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DECEMBER, 1952

VOL. 18, NO. 3

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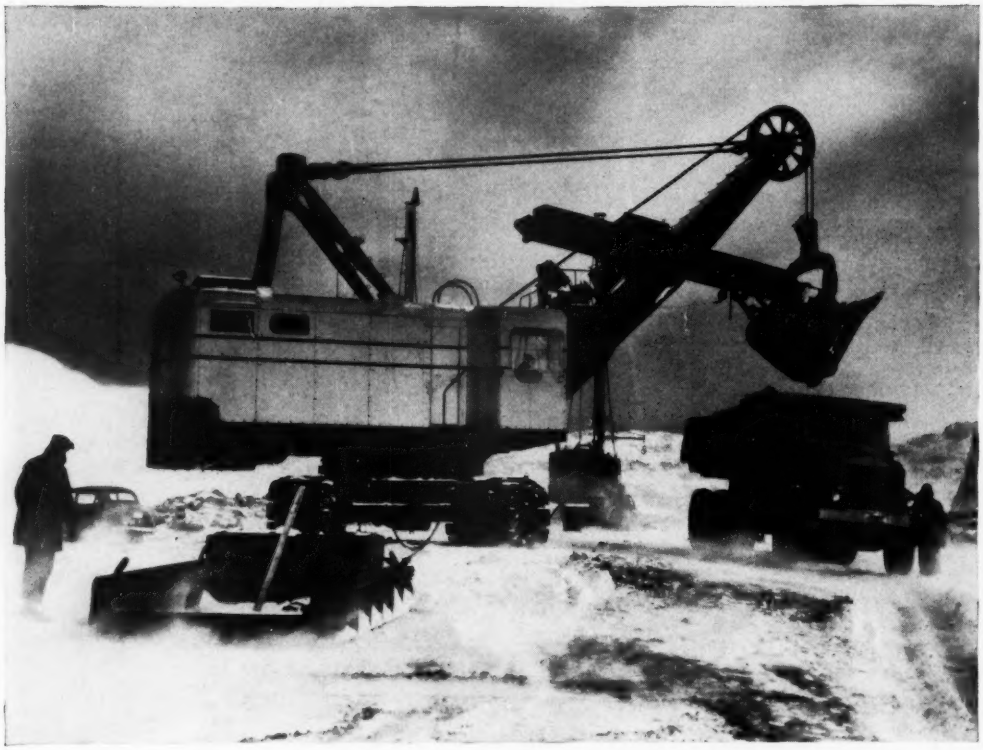

# There's been a cold war on in Minnesota lately

. . . And our metallurgists have won it.

Up in the iron ore range, where 40 below zero can be expected frequently, shovel operators usually plan their operations to remove a year's supply of ore during warm weather months when the ore is workable. But recently, with steel requirements ever increasing, shovel operators began working around-the-calendar.

And they ran into trouble.

During one cold spell when the temperature dropped to 40° below throughout the iron ore range, the ore froze solid. The extreme cold caused steel in the equipment to lose some of its toughness, and power shovel booms and dipper sticks broke all over the range as the huge steel dippers were rammed into the frozen ore with tremendous force.

But there was one significant exception. Operators using shovels with booms and dipper sticks made of one particular steel went right on gouging up frozen ore without any equipment trouble.

Those shovels stood up because the heavily stressed parts were made from U·S·S TRI-TEN—a remarkably strong steel that has a high degree of toughness, even at low temperatures.

Moreover, the users were able to cut the weight of their TRI-TEN parts by 25%, even though some working stresses were increased 50%. "And," says one shovel manufacturer, "TRI-TEN steel has enabled our customers to operate this equipment successfully at temperatures as low as —45°F."

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U·S·S TRI-TEN is only one of hundreds of steel compositions developed by United States Steel to meet special service conditions. Trained U. S. Steel metallurgists work with manufacturers all over the country to help solve problems involving the more efficient use of steel. United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pa.

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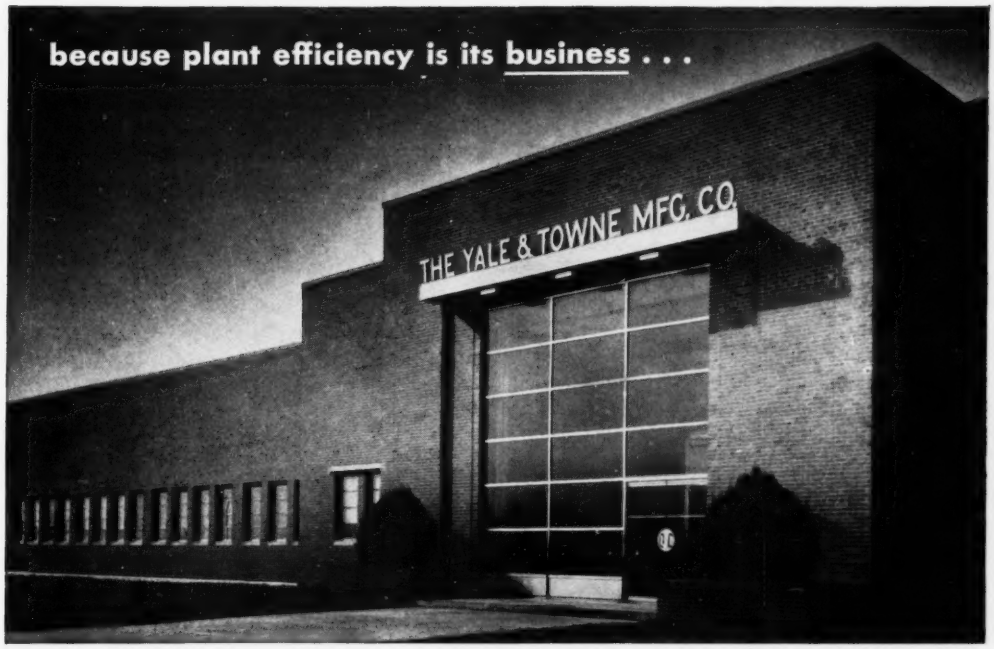


*Architects:* THE BALLINGER COMPANY. *Contractors:* TURNER CONSTRUCTION CO.

## YALE & TOWNE selects JENKINS VALVES

What Yale preaches, it practices. The Yale & Towne Philadelphia plant, newest and largest materials handling plant in the world, is engineered for top production speed, economy and efficiency.

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With the nation's top-flight building specialists, the only true economy is to install the best valves money can buy. This confidence in the *extra measure* of efficiency and endurance built into Jenkins Valves is shared by plant operating staffs in every type of industry.

Yet despite this extra value, *they pay no more* for Jenkins Valves. For new installations, for all replacements, the Jenkins Diamond is their reliable guide to lasting valve economy.

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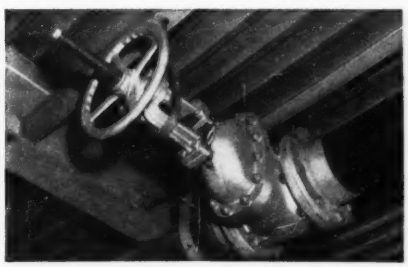
**Numbering more than 3000,** and ranging in size from ½ in. to 8 in. Jenkins Valves assure trouble-free fluid control at Yale & Towne's new plant. One of the large gate valves, on a water main, is shown above.



JENKINS
LOOK FOR THE DIAMOND MARK
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# Hitting modern military targets poses ever-new engineering problems

This booklet — "Engineering at Arma" — describes in detail the challenges of an engineering career at Arma. It can open new horizons to you. Write today for your copy to Engineering Division, Arma Corporation, 254 36th Street, Brooklyn 32, N. Y.

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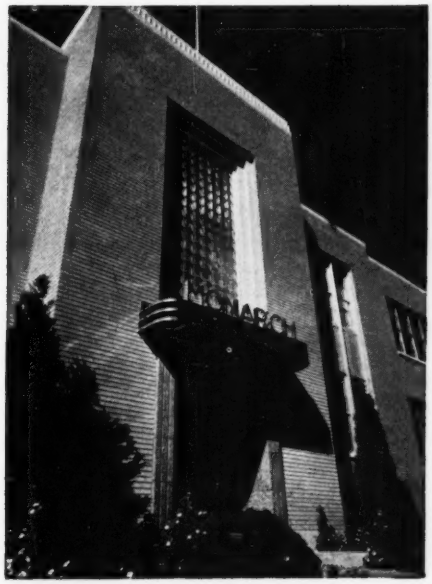

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Electrical energy is restless . . . would jump at any chance to escape—if it could.

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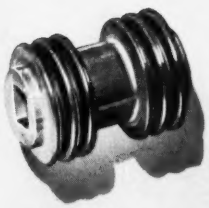
Synthane laminated plastics are used in transformers for spacers and coil forms because it is an insulator unaffected by oils; in tap changer panels because it is a machinable insulator with high dielectric strength; in "Glowtectors" because of high insulation resistance and abuse-resistance; in circuit breakers and bus bars for its arc resistance.

Synthane, an unseen essential to power generation, transmission, and control, may be helpful to you. Send for your copy of the Synthane Catalog and learn all about Synthane's combination of electrical, chemical, physical and mechanical properties. Synthane Corporation, 10 River Road, Oaks, Pennsylvania.

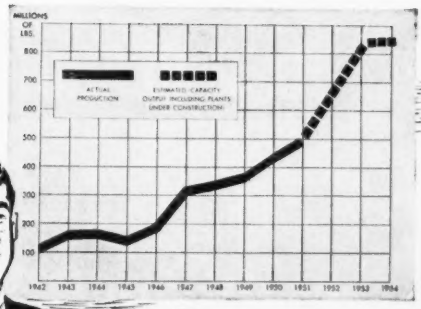


**PETTICOAT STANDOFF INSULATORS machined from Synthane square-hole tubing. Here, Synthane was specified for its good dielectric properties, machinability and rugged strength.**

*Synthane-one of industry's unseen essentials*

**SYNTHANE**

**LAMINATED PLASTICS**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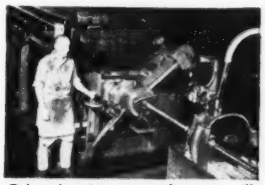
Reynolds expanding production —historic chapter in 33 years of continuing growth.

# A Fertile Place for Careers to Grow...



Settling tanks, where impurities are separated from sodium aluminate



Tube drawing, one of many mill operations at Reynolds

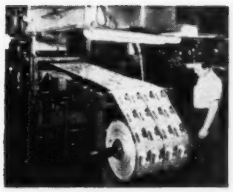
A broad vista of opportunity opens up for college graduates who come to work for Reynolds. The phenomenal rise of the Reynolds Metals Company, known throughout business and industry, is clearly depicted by the above chart. The five-fold expansion in total production of aluminum ingot alone spells broad opportunity. Add to this the vast and productive fabricating facilities of Reynolds —in themselves an enterprise of considerable proportions—and here indeed is a fertile field for any ambitious engineer.

From bauxite mining through metals refining and fabrication to application engineering, sales and marketing, Reynolds offers broad career opportunities. Operating 27 plants in 13 states, and still expanding, there is virtually no limit to what can be accomplished by a capable graduate engineer.

Preliminary orientation in production and sales...direct on-the-job training...liberal insurance, hospitalization and retirement programs...these are all parts of a sound personnel policy maintained at Reynolds.

For important information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.

# REYNOLDS ALUMINUM



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**Name**_____

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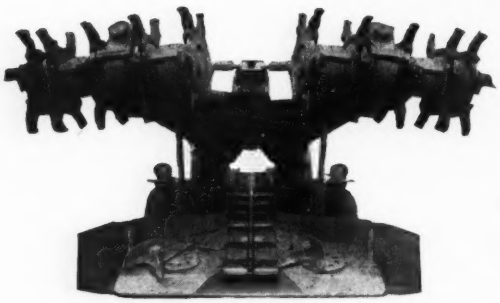
*Another page for* **YOUR BEARING NOTEBOOK**

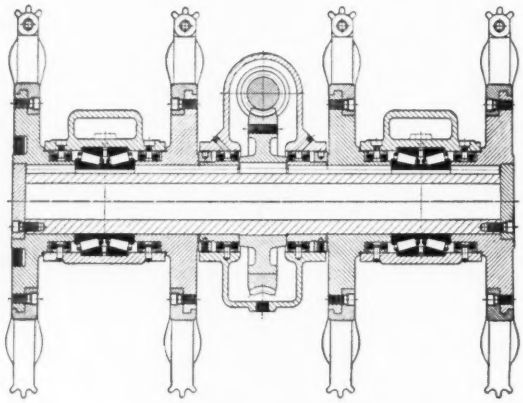


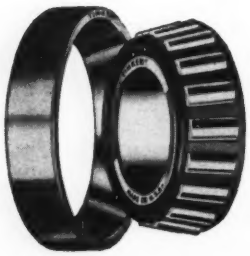
## How to help a "miner" cut and load 2 tons a minute

This mechanical "Miner" cuts a coal seam and loads the coal, too—at the rate of 2 tons a minute! To insure this kind of performance, engineers used 86 Timken® tapered roller bearings on cutter heads and vital shafts. Due to line contact between rollers and races, Timken bearings have extra load-carrying capacity. Their tapered construction lets them carry radial and thrust loads in any combination. Shafts are held in positive alignment. Wear reduced. Trouble-free performance assured.

## How to mount cutter heads on TIMKEN® bearings

Two-row Timken bearings, pre-adjusted at the time of manufacture, are used in all supporting positions of the cutting head assembly. The bearings are fixed in the housing at one end (left), and permitted to float in the other (right). Because of extreme dirt conditions encountered in the mining operation, a special type of two-element seal is used. Lubricant is forced between the two seals to give maximum protection to the bearings inside.





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Some of the engineering problems you'll face after graduation will involve bearing application. If you'd like to learn more about this phase of engineering, we'll be glad to help. Clip this page for future reference and for a copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

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The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the chain of American business.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Harrison, New Jersey.

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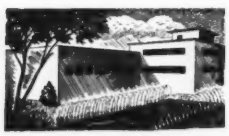

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# THE DU PONT DIGEST

## Plant and Equipment Design and the Engineer

**At Du Pont, men with many types of training translate laboratory developments into full-scale production**

**Roger Jones,** *B.S. in Chem., Haverford College '52 (right), and operator check temperature control in the conversion of furfural to furan.*

Among the most interesting fields for engineers at Du Pont is the design of plants and equipment.

It takes ingenuity of a high order to translate a small-scale laboratory operation into all-out commerical production. Design engineers cannot always use purchasable equipment to scale up research findings, even with considerable adaption. About half of the time at Du Pont, entirely new equipment must be designed because of the novelty of the process developed by research.

For example, a number of unusual problems were involved in designing the equipment and plant for a process in which hexamethylenediamine, one of the intermediates for nylon, is made from furfural, derived from such agricultural by-products as corncobs and hulls of cottonseed, oats and rice.

*In this conversion, these steps are involved:*

$C_4H_3OCHO$ (furfural) $\xrightarrow[\text{catalyst}]{\text{Heat}}$ $C_4H_4O$ (furan)

$2H_2 \longrightarrow C_4H_8O$ (tetrahydrofuran)

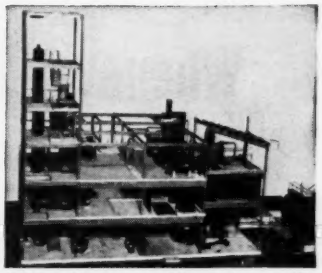
$2HCl \longrightarrow Cl(CH_2)_4\,Cl$ (dichlorobutane)

$2NaCN \longrightarrow NC(CH_2)_4\,CN$ (adiponitrile)

$4H_2 \longrightarrow H_2N(CH_2)_6\,NH_2$ (hexamethylenediamine)

*Here are some of the special problems that were encountered:*

**1. Design of equipment** with close temperature control for converting furfural to furan. The design finally settled on employs a large number of tubes containing a catalyst, with a coolant circulated around them. Special sequence timers were devised for operation of the valves controlling production and regeneration cycles.



**Scale model** *of a part of the plant where adiponitrile is made from furfural.*

**2. Design of high-pressure** agitated autoclaves for the hydrogenation of furan to tetrahydrofuran.

**3. Selection of corrosion-resistant** equipment for the hydrochlorination of tetrahydrofuran to dichlorobutane at high temperatures.

**4. Design of a unique** five-step distillation train to obtain high-grade adiponitrile without trace impurities.

Although most of these problems involve a great deal of chemical engineering, also needed on the designing team were mechanical, electrical, civil, metallurgical and industrial engineers. Thus design work at Du Pont is open to men with many types of training, and there is abundant opportunity for all.

**E. W. Griffin,** *B.S. in M.E., Duke; M.S. in Ind. Mgt., Georgia Tech '52 (right), instructs operator in handling of vapor-tight horizontal vacuum filter used in separating adiponitrile from sodium chloride.*

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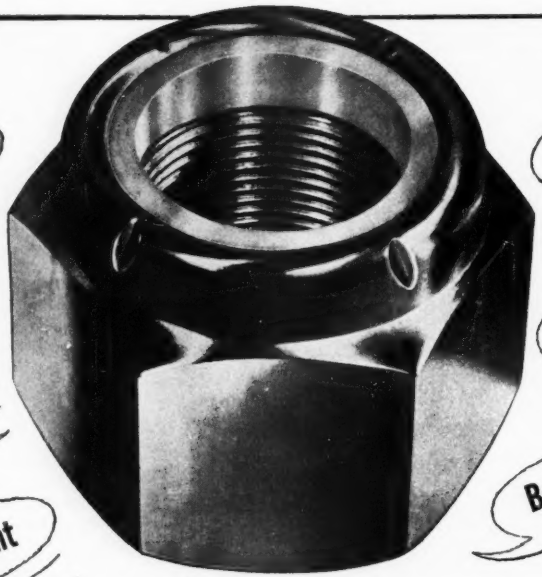


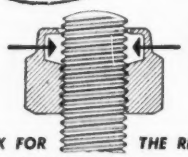

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### THE NEW OPENINGS

The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment. Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

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On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work with us.

### WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

### YOUR FUTURE

In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training in and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

## *How to apply:*

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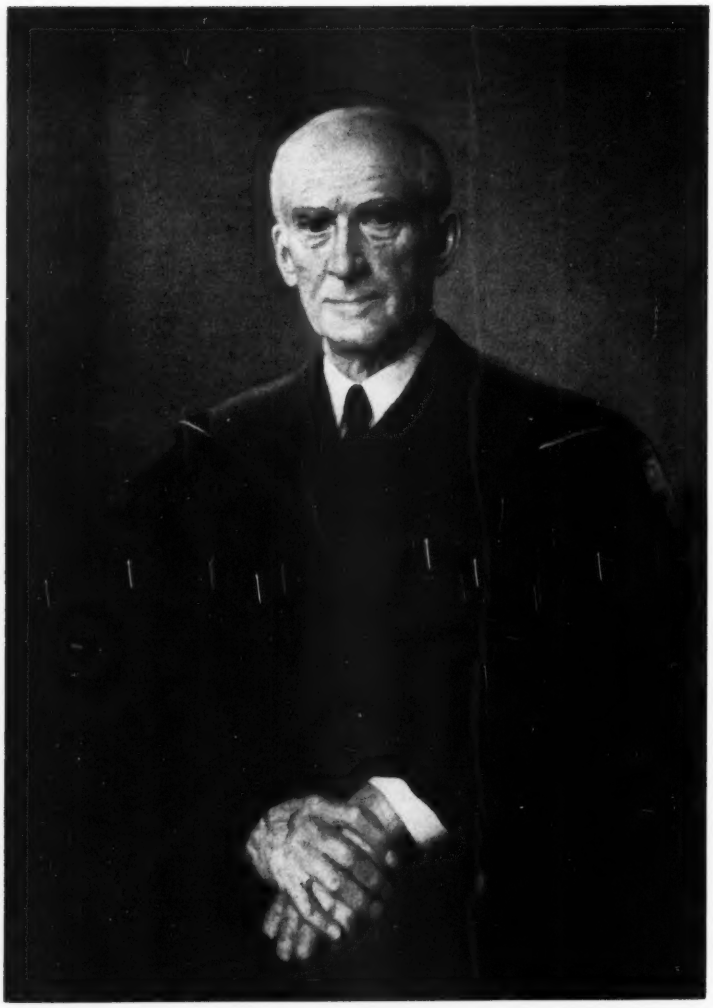
*Engineering Personnel Department*
*Culver City, Los Angeles County, California*

*See your Placement Office for appointment with members of our Engineering Staff who will visit your campus. Or address your resumé to the Laboratories.*



# DEXTER S. KIMBALL

Dexter S. Kimball has gone—and we have lost a friend. His death has brought sorrow to thousands of Cornellians, members of the local community, and those who knew him in professional life. Few men have left such a vivid impression on the University as did he—an impression etched by an unselfish devotion to his work and a heartfelt love for Ithaca, Cornell, and the students to whom he was a constant source of inspiration and encouragement.

It is impossible not to be superlative when describing a person such as this in the light of his accomplishments as an engineer, educator, administrator, and simply as a man. For more than half a century he was one of the best known and most loved personalities on the faculty. Even after his retirement in 1936 as Dean of the College of Engineering, he was a popular figure on the Hill, remaining energetic and active until his death.

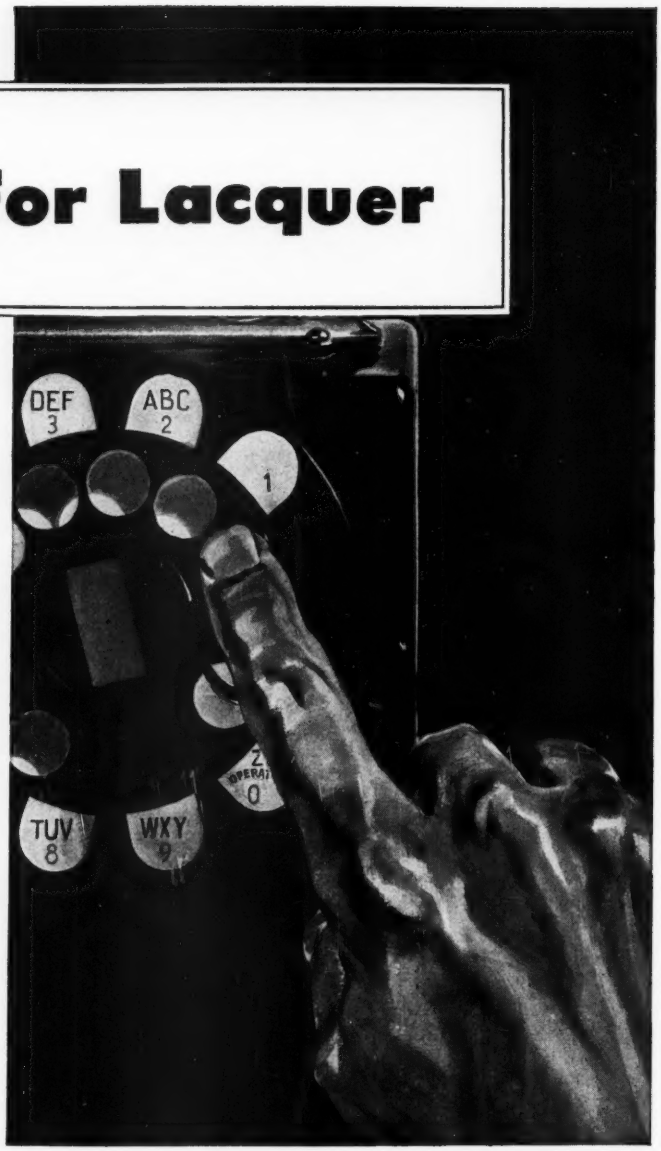
Although his name is naturally associated with the engineering school, there was hardly a phase of campus activity that did not claim his attention. His broad and sympathetic interest in student affairs were well known, as might be expected from one who cherished academic freedom to extent he did. Many came to know him through his lectures and after - dinner speeches at University functions and before Ithaca meetings. His talks were always characterized by farsighted and progressive thinking and covered the widest range of topics imaginable—it seemed that hardly a subject existed with which he was not familiar. His mental vigor was impressive to the very end.

Dean Kimball was one of the last survivors of the men who were instrumental fostering the early development of the University. His influence here is further appreciated in view of the fact that when he arrived at Cornell in 1899, engineering in higher education was still meeting opposition from those who believed that such a course did not belong in a university, but rather a trade school. Also, due to his efforts, the first course in administrative engineering was established on the campus. From this unobtrusive beginning grew the present Department of Industrial and Engineering Administration.

It is virtually impossible to express in words what the loss of Dexter S. Kimball means to Cornell and to the friends he left behind. Having added so much lustre to the local scene while working tirelessly for the University, its students, and alumni, it is difficult now to think of him as having departed from our midst. He shall never be forgotten, however, for he shall continue to live in the minds of Cornellians everywhere as a symbol of the mighty institution he helped to build.

*(The frontiecpiece portrait is by Thomas E. Stephens)*

# Calls For Lacquer

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## MEMORIAL PROFILE

# DEAN DEXTER S. KIMBALL

By WALTER L. JONES, EP '55

On the twenty-first of October, just a few days before his unexpected death, Dexter Simpson Kimball, professor emeritus and one of the most notable men in Cornell's history, celebrated his eighty-seventh birthday. Then, as within a few hours of his passing, he was an active, vigorous man, carrying on the work in Cornell engineering that he had done for fifty years. As professor, dean, acting president, friend, and advisor, he had led us and taught us well. The record that follows is one of which both he and Cornell may be proud.

Professor Kimball was born in New River, New Brunswick, in 1865. He was raised in the strict atmosphere of New England family life. It was here that the drive and initiative that carried him far in later life were developed. At sixteen he started to work as a journeyman for Pope and Talbot. After six years he went to the shops of the Union Iron Works, where he stayed until he was twenty-eight.

At this point he went west to Stanford University to pursue higher education. There he earned his A.B. degree. He was a member of Kappa Sigma Fraternity and was very active in undergraduate activities. After this he returned to Rochester University, where he obtained his degree in M.E. and received five honorary doctorates; an L.L.D. from Rochester, Doctor of Science from Case School of Applied Science, and Doctor of Engineering from Kansas State, Northeastern, and Lehigh.

After completing his formal education, Professor Kimball returned to the Union Iron Works, this time joining their Engineering Department. He worked there until 1898. His company at that time built some heavy machinery for the Anaconda Mining Company, and Professor Kimball was loaned to them to supervise the installation. Professor Barr at Cornell heard of Kimball's reputation while he was with Anaconda and asked him to come to Cornell as an associate professor to teach a course in the design of heavy machinery.

He stayed at Cornell from 1898 to 1901 in this position. Then he was offered a post as works manager for the Stanley Electric Mfg. Co., a new subsidiary of Westinghouse. Feeling that he was accomplishing nothing at Cornell, he left for three years. In 1904 he returned as full professor, teaching what was probably the first administrative engineering in this country. He taught this course through 1915, when he and two other professors formed the School of Industrial Engineering.

It was this period that Professor Kimball believed was the heyday of Cornell Engineering. At the turn of the century, there were only two engineering schools: the College of Civil Engineering and the Sibley School of Mechanical Engineering. The colleges were chiefly concerned with the "mechanical arts" of drafting, drawing, and rudimentary construction. Under the leadership of Professor Thurston (after whom the new materials lab has been named) and later Professor Kimball, this was changed, and the system of engineering as we know it grew up. Thurston gathered men such as Kimball and Barr together and taught practical engineerig.

The school was smaller at that time and the faculty lived in houses close about the quad. It was a much more intimate group than now and Professor Kimball thought it a fine place for his children to grow up. The faculty of that time were responsible for Andrew White's singular lack of rules governing the students. If a man did his work and behaved as a gentleman, he stayed; otherwise he left.

In 1920 the various colleges were split into separate schools under one College of Engineering and one dean. It was only then that the School of Electrical Engineering became anything but part of the Sibley Mechanical Engineering College. As the authorities turned about to find the man to serve as dean, the outstanding choice was Dexter Kimball. He was a man who knew his engineering backwards and forwards. But more important, he had already shown leadership. He had been works manager of Stanley Electric; he had helped to organize the Industrial Engineering program; and during the war he had been fuel administrator for Tompkins County and directed the Cornell Army Mechanics Training program. And so, from 1920 to 1936, when he retired, Professor Kimball served as first dean of the College of Engineering.

But this did not keep him from taking part in many other activities. He was president of both the Ithaca Chamber of Commerce and Community Chest, two organizations in which he was very active until his death. He wrote eight texts and over three hundred papers and articles. He was president of the Cornell University Athletic Association. In 1927 he was chairman of the Organizing Committee of the second Pan-American Standardization Conference. He was a member and national president of A.S.M.E. in 1921 and 1922. He served as vice-president for the next two years for S.P.E.E., and then advanced to the post of president. The Federated American Engineering Societies elected him their vice-president.

From 1926 to 1928, he was president of the American Engineering Council. Also a director of McGraw-Hill Publishers, he was a member of Sigma Xi and national president of Tau Beta Pi, in addition to being president of the Cornell Chapter of Phi Kappa Phi.

After all this, Professor Kimball stoutly maintained that the greater income to be found in industry in comparison to teaching is more than compensated for by greater working strain in the former.

Professor Kimball retired as Dean and added an "emeritus" to his title in 1936. But, in his own words, "Retiring isn't quitting." He was a Steinmetz lecturer and a Brackett lecturer at Princeton. He was also active in connection with several awards, both on the giving and the receiving ends. He was a member of the H. L. Gantt Medal Board, chairman of the John Fritz Medal Board, and first president of the Herbert Hoover Medal Board. In turn, he received the H. L. Gantt Medal himself, and also the Lamme Medal from S.P.E.E., and the Warner Medal from A.S.M.E.

With the start of World War II, Professor Kimball was again pressed into service. In 1941 he served on the Priority Board Committee on Machine Tools, and in 1942 he was made a high national official of the War Production Board. At that time the navy was bringing qualified men ashore to serve as inspectors in plants. Professor Kimball was asked to run a series of lectures for these men on what they would find in industry. After ten years he was still making these lectures, having just completed his thirty-fifth trip to the West Coast to conduct the last series.

Professor Kimball had little time for leisure activities, even in the last years of his retirement. He didn't play golf, for he thought he was "not old enough for that yet." He had been busy revising one of his texts with his two sons (both were Cornell graduates) and Professor Schultz. He was also putting the finishing touches on his autobiography, a book that should now be of very great interest.

For half a century, Professor Kimball was an integral part of Cornell history. He watched our engineering colleges grow and helped them to their maturity. Cornell is left owing this man a great debt, not one that can be repaid by testimonials and memorials, but only by the quality of men that leave this school, men better for the work that he did here. It is with regret that we write "the end" to his list of achievements, which, had he lived, would have grown for many years to come.

# Letters To The Editor

To the Editor:

I enjoyed the editorial, "Where Are the Women," in the October issue of the CORNELL ENGINEER, and quite agree with Miss Janice Button that the "fair sex" should more numerously seek to qualify themselves for the more technical pursuits. The editorial mentions two women who have attained distinction in the engineering field, Edith Clark whom I do not have the pleasure of knowing, and Lillian Gilbreth, whom I have known since 1915 or thereabouts. But it omitted to mention my CE girl classmate ('05), Norma Stanton Blatch, granddaughter of Elizabeth Cady Stanton, who became Mrs. Lee DeForest and eventually Mrs. Barney, for long years now a resident of Greenwich, Conn., where, for many years, she has carried on a successful development business.

Nora, on graduation, went to work for the American Bridge Co., as a draftsman, and, I was told, acquitted herself very creditably. She has always kept her hand in the practice of her chosen profession, despite two marriages and raising a family. During the period of F.E.A. of Public Works, under the late Harold L. Ickes, she served for a while as a Resident Engineer Inspector. I was at the time in a like capacity and saw her at State Headquarters occasionally. The last time we went together to call on Clara Garfield Cornell ('06), who had for years been confined to her bed with arthritis, in her apartment at Black Rock (Bridgeport). I have neither seen nor heard from Nora since, but from all that I know, she is still carrying on. Mr. Barney is a naval architect.

Nora was the first girl ever to matriculate in C.E. at Cornell. I had her in my squad on the Junior Survey. I think that she has continued to be active in movements to advance the rights (so-called) of women, but not nearly so much as nor so prominent as her mother. Mr. Blatch was an Englishman and Nora had some of her early schooling abroad.

With all good wishes
Sincerely yours,
HARRY F. PORTER, C.E. '05
Glastonbury, Conn.

To the Editor:

I would appreciate permission of you and the author, Janice Button to print in THE BRIDGE OF ETA KAPPA NU her editorial, "Where are the Women?" which appeared recently in the CORNELL ENGINEER."

Sincerely yours,
A. B. ZERBY
Editor and Business Manager
THE BRIDGE OF ETA KAPPA NU
Dillsburg, Pa.

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To the Editor:

If you will kindly send four copies of the October issue of the CORNELL ENGINEER I will be glad to distribute them to several youngsters who are contemplating the pursuit of an engineering course at Cornell University. There are some items in this particular issue that will be extremely attractive to these young men.

Very truly yours,
F. ELLIOT WOOD, Manager
International B. F. Goodrich Co.
New York 17, N. Y.

# a look to the future

## ...YOU and DETROIT EDISON

**BEFORE YOU CHOOSE** the place where you'd like to work, look ahead. Carefully consider the character of the company you'd like to join.

Ask yourself if it is a progressive concern, led by men of energy and vision. Does it provide a wide variety of jobs that lead to positions of higher trust? Is it a *company with a future*—one that will reward your loyalty, ability and accomplishments with well-defined *opportunities for advancement?*

Detroit Edison is widely recognized as such a company.

It is an independent electric utility—one of the largest in the United States. Detroit Edison is owned by 60,000 investors and operated by 11,000 employes, who serve 3,500,000 people living throughout the key industrial and agricultural section of southeastern Michigan.

The Detroit Edison Company is a forward looking enterprise with a half century of progress to mark its present growth. As an example of its foresightedness, Detroit Edison engineers are working with Dow Chemical Company as one of our country's four atomic research teams. They are investigating the use of nuclear heat in thermal electric generating plants . . . an investigation pointing toward better ways to provide electric power for the nation.

It is an aggressive company keeping constant pace with the productive area it serves—a utility which during the last six years has increased its electric generating capability by 50 per cent—and by 1954 will have doubled its facilities of a decade ago.

This steady march of progress calls for a continued program of expansion . . . it demands able men of many skills to assume new positions of responsibility in scores of different jobs.

There is no limit on your initiative at Detroit Edison. You may select your starting job through an orientation program which also allows you to observe many of the Company's operations as a background to your successful future. And, once started, you are encouraged to advance as far as your ability and energy will carry you.

Here indeed is a firm and satisfying foundation on which to build your own career—Detroit Edison, a company that looks ahead for its employes as well as for the customers it serves.

## The Detroit Edison Company

# The New Look in Electric Locomotives

By HENRY F. DIMMLER, EE '54

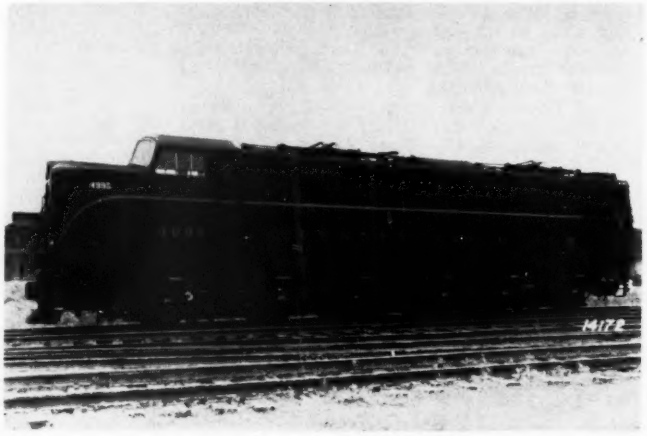
The past decade has found a veritable revolution occuring in the field of railroad motive-power development. The steamer—once the dominant figure of American rails—has now become a nonentity. It can be safely said that American railroads have accepted the electric drive as the most superior means yet developed for application as a prime mover. The diesel-electric locomotive with its inherently good traction qualities, high availability and lower maintenance costs, caused the downfall of steam power and at present enjoys top billing on the motive power rosters of most U.S. railroads. Not content to stop with the attractive economies and performance of the diesel locomotive, motive power experts continued their researches and came up with the gas turbine-electric locomotive. Characteristics of the turbine drive (CORNELL ENGINEER, April, 1950) at least matched those of the diesel and further development indicates that the diesel is already faced with a challenger.

However, until 1948, development in the field of straight-electric locomotives (taking power from an overhead catenary) remained practically static. Despite the fact that a straight electrification will pay good dividends on a long-term basis, attention was directed toward greater perfection of self-contained power units such as the diesel and turbine-electric locomotives. This is explained by the fact that such self-contained power plants offered almost immediate savings to the railroads while electrification is a costly business, paying off only after large initial expenditures for substations, overhead lines etc.

**Undertake New Design**

Several large railroads in the U.S. presently have sections of electrified main line (Pennsylvania, Virginian, Great Northern and New Haven). These divisions have been in use for many years and have conclusively proved that, on a long range basis, electrification is a very attractive proposition. However, producers of railway motive power were reluctant to climb out on a limb by developing new and better straight-electric locomotives when the market was small compared with the diesel-electric market. At the height of the switch to diesel power, both General Electric Company and Westinghouse Electric Corporation did embark on such a project and, following greatly differing paths, have come up with two completely new straight-electric locomotives. Both locomotives were designed for use on the New York-Harrisburg-Washington division of the Penn-

**The ignition-rectifier locomotive (single unit) designed and built by Westinghouse Electric Corp. for use in heavy freight duty on the Pennsylvania Railroad.**
*—Westinghouse*



sylvania Railroad, but demonstrator models are now being tested on other electrified roads in the country.

The GE locomotive is more or less conventional in basic design—twin coupled units rated at 2500 hp each taking 11,000 volts, 25 cycles single-phase from pantographs and feeding 230 volts to each of the eight a-c traction motors. The Westinghouse locomotive is a new-comer to the railway motive power field, employing banks of ignitron rectifier tubes to convert the 11,000-volt single-phase a-c coming from the pantographs to supply full-wave rectified d-c to each of the 12 conventional diesel-electric traction motors. Since these two locomotives differ radically in principle of operation, it is best to consider each separately and then compare their relative performances. Since contacts with both companies indicated the Pennsylvania was willing to accept locomotives differing from conventional a-c types providing superiority over the straight a-c indicated, both firms had a relatively free hand in choosing the general path to be followed in developing the new locomotives.

### Basic Considerations

In the design of the GE locomotives, engineers were mainly interested in simplicity and reliability, utilizing basic components previously proven in service. A survey of traffic on the Pennsylvania's electrified division showed that a 4-axle locomotive capable of operating in from 1 to 4-unit combinations was most desirable. It was decided that the a-c commutator motor with its inherent high horsepower output and its ability to take 25-cycle power from the overhead line without intermediate conversion equipment would be used as the main traction motor type. Other advantages in favor of using this conventional straight-electric equipment included simplicity of mechanical construction and electrical circuits and the high short-time ratings possible with the use of overvoltage transformer taps.

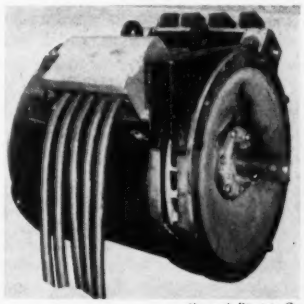
The mechanical design resembles the modern diesel-electric locomotive in several ways. Two streamlined, single-cab units are carried on two sets of double axle swing-bolster trucks. The cab and platform structure is fabricated from steel and the entire unit is designed such that construction on a sub-assembly basis is possible. This was done for the purpose of possible future mass production of identical units on an assembly line (one outstanding reason why diesel-electric locomotives are relatively low in cost per output hp). The location of all apparatus was given top priority in design of the units since one of the prime factors influencing maintenance cost is accessibility of equipment.

Power for auxiliary equipment is provided by a motor-generator set consisting of a single-phase 25-cycle induction motor for driving, a 125-cycle three-phase alternator supplying the axial-flow traction motor blowers and a 37.5-volt d-c generator for control circuits and battery charging. The air compressor is driven by a 25-cycle single-phase induction motor.

The traction motors are standard a-c 25-cycle single-phase 16-pole commutator type with commutating poles and pole-face windings. Each motor is rated at 230 volts with continuous output of 625 hp and short periods of overload needed in starting and climbing provided for by overvoltage taps on the transformer. This transformer, rated at 2,655 kva, 11,000/762 volts, 25 cycles single-phase, is pyranol filled and forced ventilated. Traction motors are connected in two parallel groups, each group with two motors in series. A total of 21 control steps is provided by a 3-preventive system of coil notching on the secondary winding.

### Dynamic Braking Included

Dynamic braking, which is now widely used on diesel-electric locomotives, is included in the design



—*General Electric Co.*

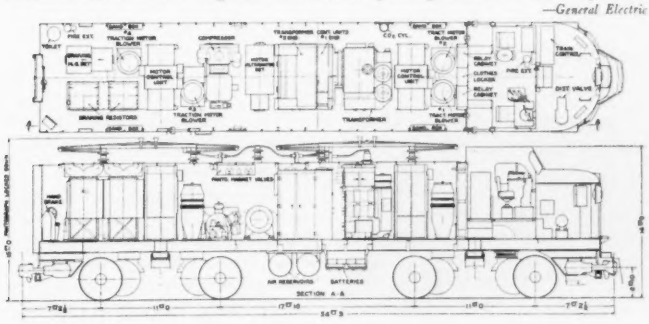
**The 25-cycle a-c commutator traction motor as used in the General Electric freight locomotive. View is from the pinion end.**

features of the a-c unit (the first such application on a straight a-c locomotive in the U.S.). When the main controller is in the braking position, the traction motor armatures are connected in two parallel groups of two armatures in series. These two series armatures operate as d-c generators across a constant-value braking resistor. All four fields are connected across a low-voltage d-c exciter whose shunt field is supplied from the 37.5-volt d-c control circuit. Degree of braking applied is controlled by varying this exciter field. Each braking resistor is of strip ribbon construction wth a d-c motor-blower set connected directly across it, thus providing a rate of air-flow proportional to braking current.

The master controller includes a main acceleration handle, a reverse handle, a braking handle to control dynamic braking and a selector handle controlling the motor-alternator set. Intermediary sequence re-

**Schematic view of the a-c freight locomotive showing arrangement of various components.**

—*General Electric*



lays operated by the acceleration handle actuate transformer tap contactors for tractive-effort steps from stop to top speed.

Wheel slip protection is provided by both a power tie connecting mid-voltage points of both 2-motor series circuits and a-c and d-c voltage relays operating on a potential difference between the two motors in each series group. The power tie automatically provides for a current build-up on the more heavily loaded axles and a decrease on the lightly loaded axles. The relays provide for cab warning and automatic tripping at excessive slip.

The GE locomotive was designed to meet certain basic requirements:

1. Unit size to give the most efficient use over a wide range of traffic conditions.
2. Use of already-proven equipment.
3. High horsepower.
4. Equipment arrangement to give ready access for inspection and maintenance.
5. Higher availability with lower operating expense.
6. Lower first cost.

Advantages of advanced design coupled with benefits of using standardized components were utilized to meet these requirements. Operation to date seems to indicate that the initial objectives have been attained.

**Rectifier Locomotive**

The Westinghouse ignitron-rectifier locomotive represents an entirely different approach to the design of all-electric motive power in which the best features of both a-c and d-c electrification system are combined. Westinghouse engineers coupled the low voltage d-c series-wound motor which has already been proven as superior for traction purposes (such motors are used exclusively in diesel-electric locomotives) with the good transmission and distribution characteristics afforded by the single-phase a-c overhead feed. Recent improvements in ignitron tube construction and ratings have made possible their application as high power devices and previous experience with such a rectifier installed in a trial multiple-unit car operating on the New Haven provided the background necessary for development of the igntron locomotive. Advantages of this system include applicability to a-c trolly system, high range of control at high output of d-c traction motors and incorporation of equipment now being produced in large quantities.

Mechanical design of the two streamlined single-cab units is similar to that of the GE locomotive except that three two-axle trucks are used on each unit. The center truck is free to move laterally without restraint. The two coupled units are rated at 6000hp.

A motor-generator set rated 29 hp at 1450 rpm drives the transformer blower, centrifugal pump for circulating cooling water around the ignitron tubes and a 45-volt control generator. A 35 hp induction motor drives the axial-flow blower which ventilates the radiators of the tube cooling system. Induction motor drive is also used to power the air compressor.

The 6-pole d-c traction motors are all parallel-connected with resulting impressed voltages equal at all times. The transformer, rated 4,200 kva at a primary voltage of 11,000 volts, is similar to conventional a-c transformers except for the center-tapped secondary with accelerating taps on either side of this center tap. Since only half of the secondary is used each half-cycle, the secondary is built for approximately double current rating.

**Tube Operation**

The ignition rectifier tube is a mercury arc tube employing an ignitor for striking the arc on each positive half-cycle. Two tubes per traction motor provide full-wave rectification. Two ignitron cubicles containing three firing control circuits and six anodes circuit breakers are mounted in each unit. To date, arc-back troubles have been virtually non-existent, although the anode breakers were provided mainly as protection against this. Phase delay is used with the tubes to provide an increased number of accelerating notches for a given number of transformer taps. Delay varies from 0 to 30 degrees during power operation and up to 50 degrees on braking. The accelerating taps on either side of the transformer secondary center tap feed anode reactors and d-c choke reactors on the cathode side of each tube.

Dynamic braking is provided for by exciting the traction motor fields in series through a stepped resistor and thence through the d-c chokes to the secondary mid-tap. Across each armature is a fixer braking resistance. Maximum filter capacity was built into the first locomotive with the idea of gaining information on the correct amount needed for good operation. Present data indicates that much of this filter capacity can be removed and still obtain acceptable operation.

It is interesting to note that wheel-slip protective relays have been omitted from the locomotive, experience having shown that slip in such a transmission is inherently very small. Carbon dioxide fire protection is built into each unit and provides for discharge at strategic points. All blowers are automatically shut down when any one of the carbon dioxide tanks is released.

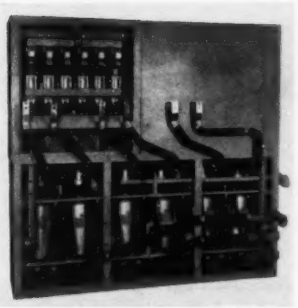
**Comparison**

Although a complete comparison of the two radically differing locomotives must wait until both have been road tested under similar conditions, several comparisons can be made with existing information.

**Builder's photo of the two-unit straight-electric locomotive built by General Electric Co. for the Pennsylvania Railroad.**

*—General Electric*

Naturally, both manufacturers claim superiority of their individual designs and with some justification. The rectifier locomotive provides greater tractive effort in the lower speed range, but the a-c locomotive proves superior in the higher speed range. Short-time overload rating of the a-c locomotive gives it superior tractive effort rating at all speeds under overload conditions. Although supposed lower maintenance costs exist when using d-c traction motors, it remains to be seen whether this will be offset by maintenance required on the ignitron units. One outstanding feature of the ignitron locomotive is its relative independence of power frequency. It may be used with conventional 60-cycle power as well as with the rail catenary frequency of 25 cycles. This would be of particular advantage if other railroads were to embark on electrification programs and decide to utilize the cheaper 3-phase 60-cycle power now used almost exclusively in most industrial applications. This would cut down high initial electrification costs and make adaptation of such a system more attractive to the railroads. Both manufacturers have created a locomotive superior in many ways to previous designs. At present, it is a toss-up as to which is the better all-round locomotive. Exhaustive rad tests must be conducted before a fair conclusion can be drawn. Nevertheless, both designs should prove that application of further electrification on American railroads offers attractive returns on investment. Thus another challenge is flung at the diesel.



—*Westinghouse*

**Ignitron cubicle (two per unit) as mounted in the rectifier locomotive. Ignitron tubes are in the lower rack with anode circuit breakers mounted above.**

# This Month's Brain Teasers

To the Editor:

I should like to contribute an original problem which could be solved by a student in the last years of grade school, but has stumped nearly everyone to whom I have given the problem. Its solution involves reasoning somewhat of the type used in the solution of your checker board problem of a year or so ago.

*Problem: can you think of a number, which is a perfect square and the sum of its digits is* 15*? If so, what is the number? If not, why is it not possible to find a perfect square, the sum of whose digits is* 15*?*

Yours very truly,
GEORGE W. LORD, C.E. '20
Jefferson City, Mo.

---

**Shown below is a problem in long division. A three digit number is divided into an eight digit number, and the multiplication, division, and subtraction works out as shown with the letter "X" used to replace all but the second digit in the quotient. What are the divisor, dividend, and quotient?**

```
          X7XXX
    ------------
XXX | XXXXXXXX
      XXXX
      ----
       XXX
       XXX
       ----
       XXXX
        XXX
        ----
        XXXX
        XXXX
        ----
           0000
```

—Contributed by
John C. L. Fish, C.E. '92
131 South Cormelina Ave.
Los Angeles 49, Calif.

---

In many sections of Russia, the peasants employed, until recently, what appears to be a very strange method of multiplication. It is similar to methods used at one time all over Europe and in Egypt as long ago as 2000 B.C.

It is most easily illustrated by an example: to multiply 45 by 64, form two columns. At the head of one put 45 and the head of the other, 64. Successively multiply one column by 2 and divide each number in the other column by 2 likewise, discarding any fractions left over. The result will be:

| | |
|---|---|
| 45 | 64 |
| 22 | 128 |
| 11 | 256 |
| 5 | 512 |
| 2 | 1024 |
| 1 | 2048 |

Cross off numbers in the second column which appear opposite an even number in the first Add the remaining numbers in the second column and you have your result: 2880. Why does this method always work? As a mental exercise prove it works by writing 45 in the binary or dyadic system as sums of powers of two.

# A New Concept In Physical Metallurgy

By GEORGE WOLGA, EP '53

Many of the engineering sciences have been developed through centuries of practice and classification of empirical observations. In recent years, however, the desire for a fundamental understanding of phenomena in these fields had led scientists to an atomistic approach in developing theories and laws. In the field of physical metallurgy the atomistic concepts are based on certain lattice imperfections called dislocations. Dislocations which are to be found in almost any real metal crystal are certain specific patterns of displaced atoms which interrupt the ideally perfect arrangement of the lattice. They have been used as essential links between the atomic structure of metals and their crystallographic plasticity.

There are essentially two types of dislocations; the edge or Taylor dislocation, and the screw or Burgers dislocation. These are illustrated schematically in Fig. 1. The edge dislocation is pictured in two dimensions but should be considered to extend into and out of the plane of the paper identically as drawn. In addition to the individual dislocations shown, there can be combinations of edge and screw dislocations joining end to end. These exist in crystals as loops which either close on themselves or terminate on the surface of the crystal.

Once consideration of plasticity phenomena in metals on an atomic scale was begun, it became evident that simply analyzing the probable behavior of a perfect crystal would be inadequate. This was emphasized by calculations which predicted that the maximum elastic strain a crystal could undergo would be about 10 per cent. This strain is about 1000 times larger than that necessary to produce deformation in tin. Evidently some other influencing phenomena were present.

## Dislocation Concept

The concept of the dislocation arises naturally as a result of the crystallographic nature of plastic flow. Essential to the early formulation of the theory were the following: the observation in strained metals of slip lines marking important crystal planes; the observation that plastic strains could be resolved into simple shears along these planes; the demonstration that plastic flow is determined by shear stresses acting on these planes showing clearly that the flow occurs by the sliding of certain atomic planes (slip planes) across each other; the fact that the structure in glide-planes remained crystalline during flow since slip occurs in the direction of closest atomic packing and

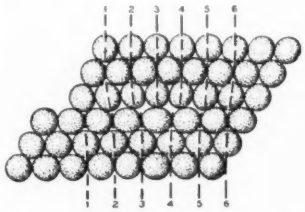



**Fig. 1a.—Schematic representation of an edge dislocation in a two-dimensional hexagonal lattice.**

not in the direction of maximum resolved shear stress, and finally, the fact that the actual critical shear stress is much less than the theoretical shear strength.

Among the elementary properties of dislocations which make them particularly attractive in plasticity theory are the following; their mobility along slip planes which result from the fact that due to the particular force field associated with a dislocation a very small force is required to move it; the slip associated with this mobility. The interpretation of slip resulting from the passage of dislocations was introduced in 1934. Fig. 2 illustrates slip amounting to one atomic distance resulting from the movement of an edge dislocation. It is quite evident that the effect achieved is that of a relative movement of the block of atoms above the dislocation with respect to the block below it.

Although mathematical treatment of dislocations is very difficult, this phase of the problem has not been neglected. A theory has been built which treats the force field associated with dislocations; the stresses produced by this field which are found to fall off inversely with the distance from the dislocation; the strain energy of a dislocation; the interaction of dislocations which act much like electrostatic charges in their mutual reactions and other reactions.

Dislocations when initially introduced were used quite functionally to explain various well known plasticity phenomena. It was a good deal later that experimental verification of their existance was finally obtained. The remainder of this article will deal primarily with these two distinct problems—the usefulness of the concept of dislocations to explain common experimental observations, and actual experimental verification of the existence of dislocations.

## Atmosphere Formation

Under certain conditions the interaction between a solute atom and the stress field of a dislocation will cause an "atmosphere" of solute atoms to form around a dislocation with the solute atoms distributing themselves so that they best fit in the region surrounding the dislocation. Since dislocations can and do move under the influence of stresses there is a critical

velocity below which the solute atoms can gather about the dislocation to form the atmosphere. A dislocation surrounded by an atmosphere when acted upon by an external force will experience a restraining force from the solute atoms. Thus the atmosphere has the effect of anchoring the dislocation. Three things can occur: the dislocation may be unable to move if the restraining force exceeds the external force; the dislocation can move if the atmosphere moves with it by a diffusion process; finally, the dislocation may break free from the atmosphere and accelerate under the influence of the external force. Micro-creep is interpreted as corresponding to the dislocation acting under the influence of the external force, carrying with it the atmosphere whose retarding influence considerably reduces the velocity with which the dislocation can move. If the external force exceeds the maximum retarding force which the atmosphere can exert, the dislocation will break away and accelerate. The force required to perpetuate plastic flow (to move the dislocation once freed of its atmosphere) is less than the force necessary to initiate plastic flow (free the dislocation from its atmosphere).

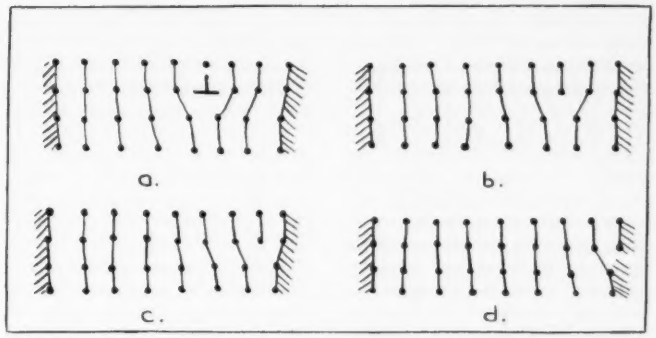



Fig. 2.—Above is the passage of a Taylor dislocation producing plastic slip in a material.

**Yield Point**

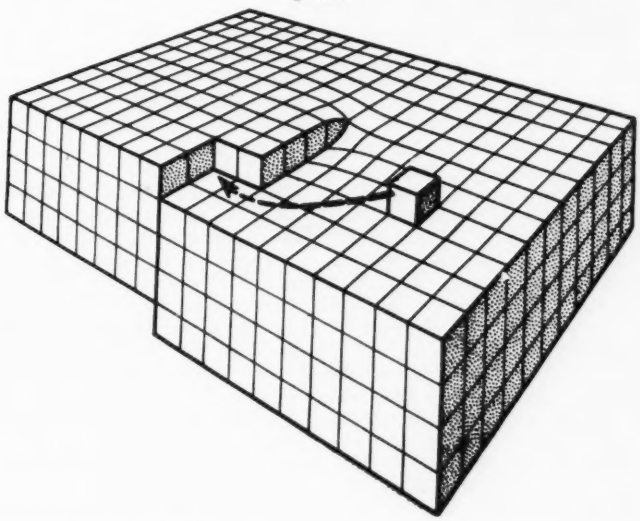
This exact situation is the requirement for a yield point. It has been well established that the yield point phenomenon in iron depends on the presence of at least .003 per cent carbon or an equivalent concentration of nitrogen atoms. The mechanism by which the carbon atoms cause the yield point is believed to be the formation of an atmosphere of carbon atoms around the dislocations. One possible drawback in this explanation is that for high concentrations of dislocations ($10^{12}$ per square cm.) as are found in work-hardened metals the required concentration of solute atoms will not normally be met.

This explanation of the yield point is backed up by the phenomenon of strain-aging. If, after yielding, the stress is released and again applied, the yield point phenomenon is not observed. A longer period without stress serves, however, to return the yield point. This is in brief what is meant by strain-aging. It is correlated to the previous discussion as follows: the yield point occurs as dislocations break loose from their atmospheres. Once free they will move (yield) under smaller stresses. If the stress is relaxed and reapplied there is no yield point effect because the formation of the required atmosphere depends on solid state diffusion which is not too rapid a process at normal testing temperatures. Given sufficient time, however, the solute atoms will diffuse to the regions surrounding dislocations and once the atmosphere is formed the yield point is restored.

In the case of supersaturated solutions, dislocations should act as centers for rapid, localized precipitation. This is in agreement with the well-known fact that plastic deformation of supersaturated solid solutions causes rapid precipitation on the slip planes.

"All crystals contain to a greater or lesser degree, regions of relatively perfect lattice which are slightly disoriented relative to one another. When such regions are of submiscroscopic size, they are usually called "domains". Those that can be observed under the microscope have been referred to as "substructure" or "cells." The nature of the boundaries between disoriented regions may be the same for domains and cells: In either case an array of dislocations could satisfy the conditions of the transition across boundaries. Futhermore, sim-

Fig. 1b.—Role of a screw dislocation in eliminating the need for nucleation in crystal growth.



ple small-angle boundaries can be made to move under the action of a shear stress, further supporting the dislocation model of such boundaries." (1).

X-ray evidence shows that after plastic deformation crystals form smaller crystallites with their boundaries at small angles to each other. This phenomenon, called polygonization, is explained by the assembly of dislocations in sheets producing crystallite boundaries as previously explained. Evidence for this has been attained experimentally.

### Hardening and Softening

"Due to its stress field, a dislocation will interact with other irregularities which are sources of internal stress in a crystal such as particles of precipitate, crystallite boundaries and other dislocations. In general the more advanced problems of the theory of dislocations are concerned with this interaction and it is by their solution that the processes of hardening and softening are to be understood." (2). The broad picture of structural strain hardening is that, as deformation proceeds, the density of dislocations increases at points where early dislocations were stuck causing higher interaction forces and yield strength. The anchored dislocations build up a pressure which locally magnifies the external stress by $n$ times where $n$ is the number of dislocations piled up. It is believed that the piled up dislocations cause crystallite rotation. This has been experimentally observed. Dislocations formed by the combined action of stress and thermal agitation at places where a notch effect exists cause a local stress concentration there. This stress field counteracts the previously existing stress at the notch thus making further production of dislocations more difficult. Consequently, less new dislocations are produced and strain hardening is built up.

Before actual experimental verification of the existence of dislocations was presented dislocations were observed to form and move naturally in two dimensional bubble-models of crystals. Perhaps the most conclusive indication of the existence of dislocations as previously described is obtained from recent studies of crystal growth. The problem of nucleation and crystal growth from saturated vapor or solution has long been a puzzling one. Isolating the individual problem of grain growth once the first few atoms have joined forming the basis for the future crystal, there were serious obstacles facing any theory concerning the promulgation of growth. Considering a partially completed crystal face as shown in Fig. 4 it is seen that the point of most probable deposition of the next atom to settle from solution would be point $A$ where contact on three faces could be made. On this basis growth could continue until this face was completed. It is here, however, that serious difficulties arise. It has been shown that the probability for the simultaneous deposition from solution of the three or four atoms required to initiate further extension of growth as described is very small. To account for the characteristic rapid continuous growth of crystals some continuous mechanism is required. This mechanism has been identified as the screw or Burgers dislocation previously described. The existence of a screw dislocation on the growing crystal face would continuously provide the required surface contact for atoms coming out of the melt. The process is continuous because as new atoms are deposited the step in the crystal surface is not obliterated as required in the previous explanation but merely revolves relative to its original orientation. (See Fig. 1b.).

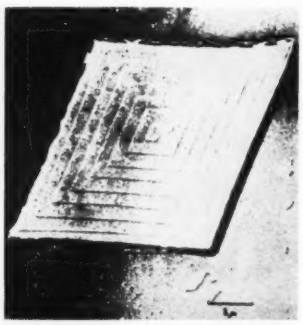


Fig. 3.—Growth steps on a paraffin crystal due to a pair of screw dislocations.

This growth mechanism received emphatic confirmation with the discovery of growth spirals on the natural faces of many crystals. Among the many crystals which have been shown to grow by this spiral mechanism are Beryl, long-chain paraffin crystal, silicon carbide and magnesium iodide. Fig. 3 is a photomicrograph of such spiral growth.

### Verification

A second important verification of the dislocation picture was more quantitative in nature. It was previously mentioned that two adjoining crystal regions with different orientation could be considered to be joined by a boundary composed of an array of dislocations. This is the case if an attempt is made to fit the dissimilar crystal structure together as smoothly as possible. If this is done then the only energy of misfit is that of the distributed strain energy of the boundary. This energy can be experimentally determined and since the energy increases with orientation difference it is usually plotted as a function of this misalignment. Similarly it is possible to calculate this same dependence on the basis of dislocation theory and the dislocation model of grain boundaries. This was done and the curve obtained is in excellent agreement with experimental results within the limits of small orientation difference or small-angle grain boundaries. This limitation is to be expected since approximations were made which hold only for small-angle boundaries.

If dislocations are indeed the mechanism by which plastic deformation takes place, then it follows that a material free of dislocations should be exceedingly strong and resistant to deformation. Up to quite recently the concept of a crystal structure substantially free of any inperfections was considered as hypothetically ideal and not to be realized in naturally occurring materials. In 1948, however, it was reported that microscopic single crystals of tin grew spontaneously in certain electrical systems, their presence being detected by performance difficulties with the equipment they contaminated. These crystals grew in a vacuum under

essentially very stable conditions and therefore it was anticipated that the material would have few if any discontinuities in the crystal structure. Accordingly, these tiny single crystals, named "whiskers" by their discoverers, were stressed in tension and observed under a microscope. It was found that the whiskers were able to withstand a deformation of several per cent without permanent deformation occurring. This elastic behavior far exceeded the normal behavior of zinc and approached the theoretically predicted behavior of a perfect crystal. These observations lent credence to the dislocation concept of plastic deformation as they were interpreted as showing the behavior under stress of a material free of dislocations.

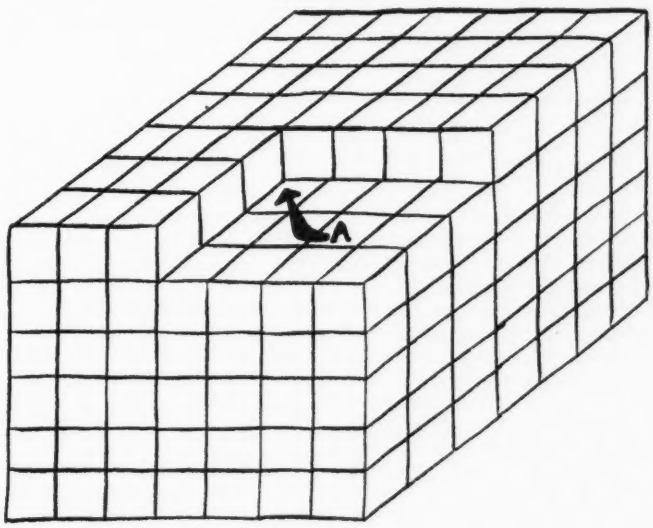
### Theory Questioned

Once convinced that the movement of dislocations is the mechanism of plastic flow, several important questions must be answered before the theory can be considered complete. Principal among these is the problem of the formation of dislocations, for, if the movement of one dislocation produces slip of one atomic distance then a very great number of such dislocations must move if slip on a microscopic level is to be observed.

Early thought concerning the origin of dislocations tried to link their origin with some imperfection or stress raiser in the crystal. Thus for a while, the stress concentration at internal cracks was considered as the source of dislocations. This explanation was discounted since the required cracks would have to be too deep and, furthermore, the plastic distortion at the apex of the crack would probably inhibit the further movement of dislocations. Similarly, the contention that dislocations originate at crystallite boundaries was based on the theory of small-angle grain boundaries being composed of an array of dislocations. This idea was also eventually rejected.

The more recent work of Frank (3) and others has thrown new light on the problem. We must again consider here the probability that dislocations may be inherent in crystals due to their role in nucleation and grain growth. Below a critical value of supersaturation, the deposition of new crystal layers will not proceed at all on dense-packed surfaces of a perfect crystal. Supersaturation is below the critical level whenever the growth of polyhedral crystals occurs. The fact that crystals do continue to grow, with rates approximately proportional to supersaturation, under conditions where they develop polyhedrally is taken to be explicable only by the presence of dislocations. Futhermore, if two places on a crystal surface nucleate in alternate positions of the packing arrangement they would join in a Shockley partial dislocation. This is not unlikely since if supersaturation is adequate to nucleate new layers in proper positions on the growing crystal surface, little extra energy would be required to nucleate in improper places. Finally, once one dislocation is formed it is possible for this dislocation to multiply and produce many additional dislocations if the crystal is stressed. A dynamic-multiplication process was discovered by Frank and Read and is described in the literature as a Frank-Read source.

Fig. 4.—Point "A" is the most probable place for the deposition of the next atom in crystal growth.




### Conclusion

It would be too presumptuous to conclude by saying that the facts are entirely clear, and when put together they unmistakably create the dislocation mechanism of plastic behavior. However, the facts available today do tie together much closer than did observations of the same nature before the introduction of the dislocation concept. The dislocation mechanism has served both to explain and predict phenomena in the plastic behavior of solids. It was in the latter that the early proponents of the theory found their justification and the new-comers discovered their incentive to accept the idea and further it. Almost all theoretical metallurgists today accept the dislocation theory and it is their growing contention that future discovery will only confirm and amplify the theory rather than discredit it. It is possible that the dislocation mechanism will eventually be found inadequate to explain everything *per se*, but it seems safe to say that dislocations will figure prominently in the final theory of metal behavior.


1 Li, Washburn and Parker—"Variation of plastic properties with Annealing Procedure in Zinc Single Crystals."
2 A. H. Cottrell—"Theory of Dislocations"—Progress in Metal Physics, Vol. I.
3 F. G. Frank—"The Origin of Dislocations."


*Illustrations* 1, 3, 4 *courtesy of* Journal of Metals.

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*"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."*

Cornell has lost a dear friend. The sudden passing of Dexter S. Kimball leaves a void which will not be easily filled, if at all. He touched the lives of many Cornell engineers who had the good fortune of receiving his instruction and advice. In addition, his contributions to society went far beyond activities at Cornell. Engineering organizations, business, other universities and government continually sought his counsel and leadership. In both of the great wars he served with distinction as chief of the priorities section of the machine tool division of the agency responsible for war production.

During my days in Ithaca I recall his speaking to groups on a broad variety of subjects ranging all the way from engineering to Greek sculpturing. Yet the full extent of his wide interests and continued inquiry were not truly appreciated by me until after graduation. He was a willing worker for our Society, gladly accepting the many speaking engagements at our meetings. In fact, he was to appear again at our December meeting. He was our favorite, small in physical stature but extremely large in knowledge, experience and enthusiasm. To him all problems were opportunities. To the end he had that wonderful gift to inspire individuals and groups with hope and achievement.

This was a rare man. All who knew him sorrow in his passing. Yet Cornell will ever cherish his memory and rejoice that our University received the benefits of his long and outstanding service.

K. J. Nelson

# ALUMNI NEWS

**Richard R. Lyman, M.C.E. '03 PhD. 05,** for more than twenty-six years head of the civil engineering department at University of Utah, was one of five on the Columbia Basin Reclamation Project for the U.S. Government. Later he worked on the Colorado River project for the Southern California District. In Utah, he lives at 1084 Third Avenue, Salt Lake City 3.

**Frank R. Ginoria, M.E. '07** has retired from district control of the several companies in the sugar, cattle, and container business which he has controlled for some time. His home is 172 Brozon Street, Habana, Cuba.

**James W. Cox, M.E. '09,** consulting textile engineer, has opened offices in Buenos Aires, Argentina, and in San Salvador. He has returned from a month's trip in South and Central America to his offices at 40 Worth Street, New York 13.

**Oliver E. Buckley, Ph.D. '14** has retired as chairman of the board of Bell Telephone Laboratories. Preident of the company from 1940-51, he was appointed by President Truman to the science advisory committee of the Office of Defense Mobilization and is still a member. Buckley lives at 13 Fairview Terrace, Maplewood, N. J.

**F. S. Hales, C.E. '16,** on August 1, was appointed executive vice-president of the "Nickel Plate Road," New York, Chicago, and St. Louis Railroad Co., with offices in Cleveland, Ohio. He lives at 3571 Lytle Road, Shaker Heights 22, Ohio.

**George L. Erwin, Jr., M.E. '17** has been elected vice-president in charge of heating sales of Crane Co., 836 South Michigan Avenue, Chicago 5, Ill. Joining the company in 1939 as assistant to the vice-president in charge of sales. Erwin was later district manager directing Crane branches in Illinois and reported in the October issue of this of the jobbed products department.

**Eduardo D. Luque, M.E.E. '23** director general, Guanosy Ferilizantes de Mexico, S.A., reports that business sales have tripled since last year and that plans are well advanced to double the production of fertilizers "which Mexican soil and crops urgently need." Lugue lives at Hamburgo 306, Mexico City, Mexico; his son is a pre-medical student at Stanford University.

**Carleton B. Quinby, M.E. '23** Perry Heights, Chappaqua, engineer, project manager with Paul Tishman Co., Inc., New York City, writes of "future Cornellian," born June 24, to his son, **James D. Quinby '53** of the Varsity football team. The grandfather has "high hopes for another football man."

**Frank Rizzo, E.E. '24** has returned from assignment in Japan as a Department of the Army civilian employee. His address is now 1892 East Fourteenth Street, Brooklyn 29.

**William W. Scull, M.E. '24,** general manager of manufacturing services of B. F. Goodrich Co. since 1947, has been named director of purchases and traffic. Joining the B. F. Goodrich Co. in 1929, he served in the company's purchasing and sales divisions until the rubber emergency during World War II when he was named chairman of the purchasing committee. He was manager of the large government rubber-making plant in Port Neches, Texas, in 1944.

**Frederick W. Parker, Jr. M.E. '27,** recently appointed executive vice-president of Timken-Detroit Axle Co., may be reached by writing to that company at 100-400 Clark Ave., Detroit 32, Mich., rather than to the Illinois address incorrectly reported in the October issue of this magazine.

**Henry Gichner B.M.E. '29,** general manager and vice-president of Ford S. Gichner Iron Works, has been appointed to the District of Columbia recreation board. He and Mrs. Gichner (**Isabelle Saloman**) **'29** and their four children live at 6115 Thirty-third Street, N.W., Washington, D.C.

**Stephen M. Lounsberry, Jr., M.E. '36** married Jane C. Cuthbert, July 26, at "Woodlawn" on the campus of New Jersey College for Women, where she was graduated in 1942. Best man was his brother, **Richard C. Lounsberry '37.** Mrs. Lounsberry was head resident in Cascadilla Hall last year. He is a partner in the manufacturing firm of Steele & Lounsberry in Owego, where they live on Forsythe Avenue.

**Austin K. Bennett, E.E. '38** has completed seventeen months recall to active duty with the US Army and has now returned to American Telephone & Telegraph Co. He has been transferred to the New York office, and has his house at 749 Hilltop Road, Springfield, Pa., to sell.

**Frederick Mills, B.M.E. '41** married Bertelle Hargrave B.S. '41 in Sage Chapel, June 28. Mrs. Mills was house director of Clara Dickson Hall. They live at 320 Blue Hills Avenue, Hartford, Conn.

**Joseph S. Mount, B.M.E. '42** received the MS in mechanical engi-

neering at University of Southern California in June. For the last three years, he has been with North American Aviation, Inc. in Los Angeles.

**Robert A. Escher, (C.E. student in '42)** is vice-president of White Construction Co., Inc., at 95 Madison Avenue, New York City. In the Navy for five years during World War II, he was a dive bomber pilot on the first USS Wasp and was assistant operations officer at Comfair, Quonset Point, R. I. He and his wife and two children live on Forest Road, Demarest, N. J.

**Charles H. Barnett, B.S. in AE '43** of 2525 Kemper Road, Cleveland, Ohio, is assistant to tthe president of Foundry Equipment Co. in Cleveland. Last March, he married Jacqueline Kalton of Paris, France, a graduate of the College of Tlemsen, French Algeria.

**Jack H. McMinn B.S. in C.E., '44 MCE, '47** was released from active duty last June 21, after spending twenty months with the Aviation Engineers designing and building airfields. He is now salesman and engineer with Western Pine Supply Co. of Emeryville, Calif. He lives at 811 B. Morley, Yuba City, Calif.

**H. Wood Bacon II, B.S. in M.E. '45** is a sales engineer with Dravo Corp. at 1346 Connecticut Avenue N.W., Washington, D. C. He has two sons and lives in Glenwood, Md.

**Howard R. Snow B.S. in E.E. '47** has a son, Robert Bartley Snow, born July 28. Snow is an electrical engineer with Radio Corp. of America. They live at 352 Bullard Avenue, Paramus, N. J.

**Rarlan P. Wallingford, B.Chem.E. '49** presently with Noyes Laboratory, University of Illinois, Urbana, Ill., has received a Fulbright scholarship to study organic chemistry at University of Amsterdam, Netherlands, in 1952-53. He lives at 405 West Elm Street in Urbana.

**Lt. Walter S. Crone B.M.E. '51** is in Army Ordnance, assigned to the Far East Command. His address is 13 Ord. A V P Co., APO 301, San Francisco, Cal.

**Lt. David E. Conklin, USAF, B.E.E. 51,** stationed at Wright-Patterson Air Force Base, Dayton, Ohio, married Jacqueline Tyner of Morristown, N. J., June 14. They are living at 101 East National Road, Vandalia, Ohio.

The appointment of Kenneth D. Scott as assistant manager of General Electric's Glass Machine Works at Cleveland, Ohio, has been announced. Scott has been manager of the Kentucky Glass Works since

**Kenneth D. Scott**

it began operations six years ago. A graduate of Cornell University, he joined General Electric at Schenectady, N. Y., in 1934. He moved to Nela Park in Cleveland the following year, and served as a member of the engineering staff until 1943, when he became an engineer at the Mahoning Glass Works, Niles, O.

**1st. Lt. Wayne H. Friedrich, Adm. E. '50,** is on active duty in Korea. Before entering the service he was employed by the Sealright Co., Inc., Fulton, N. Y. His home address is 264 Wayne Ave., Haddonfield, N.J.

**William C. Cummings, Jr., B.E.E. '50,** of 11 Roberts Avenue, Haddonfield, N. J., married Beverly Miriam John, August 23. Cummings is lighting sales representative for Public Service Electric & Gas Co. in Haddonfield.

**George S. Diehl, Jr., B.M.E. '51** is in the Army, stationed near Mannheim, Germany. His address is 7841 ORD PROC GP, APO 430-A c/o Postmaster, New York City.

**Paul H. Kirchner, B.E.E. '50** has returned to Ithaca with his wife, Doris Paine Kirchner '51, to work in the General Electric Advanced Electronics Center. They are living at 207 Water Street.

**John E. Owens, E.E. 50,** 106 Matthes Avenue, Richardson Park, Wilmington, Del., is an engineer in the pioneering research division of the textile fibers department of E. I. duPont deNemours & Co., Inc.

**Clement Darby, Chem.E. '52** and **Frank Field, Chem.E. '52,** are working for DuPont Atomic Energy Division at Argonne National Laboratory in Chicago.

**James Q. Brantley, Jr., Ph.D. in E.E. '52,** is now a member of the staff at Cornell Aeronautical Laboratory, Inc. Dr. Brantley joined the technical staff permanently after spending part of the summer under the Laboratory's summer employment program. He is employed in the Technical Co-ordination and Services Department.

**Charles C. Eeles M.E. '29,** is the new vice chairman of the Industrial and Commercial Gas Section of the American Gas Association, elected at the 34th annual convention of the association in Atlantic City, N. J. this October. Mr. Eeles is Toledo district industrial sales manager for the Ohio Fuel Gas Company. He has been with Ohio Fuel since his graduation from Cornell 23 years ago and is responsible for all sales to industrial, commercial and municipal gas customers of his company.

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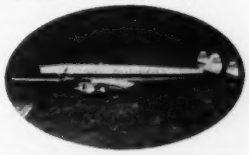

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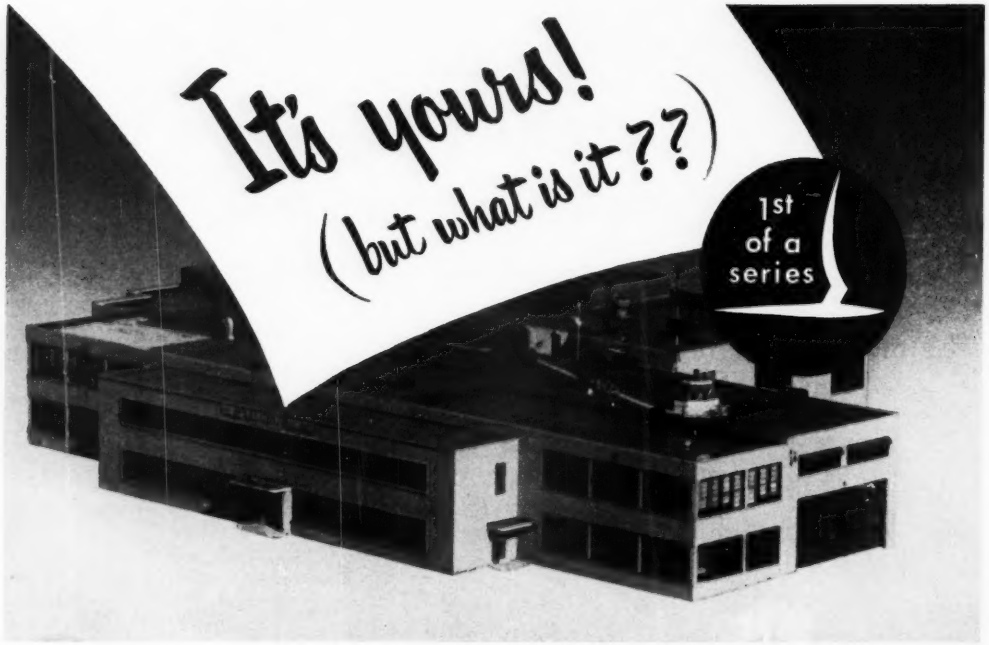


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## A MULTI-MILLION DOLLAR ORGANIZATION

A multi-million dollar organization with more than 850 employees is hard to hide under a bushel basket! Yet it would not be surprising to find that most Cornellians know little or nothing about such an organization that in part belongs to them. The alphabet soup of C.U.R.W., W.V.B.R., J.P.'s and I.F.C. is a standard diet on the hill, but the letters C.A.L. (Cornell Aeronautical Laboratory) would perhaps cause the most sophisticated B.M.O.H. to shake his head in puzzlement.

The history of the Cornell Aeronautical Laboratory is brief, even though its list of accomplishments is long. C.A.L. was formerly the Research Laboratory of the Curtiss-Wright Corporation. The main building (pictured above) was completed in 1943 adjacent to Curtiss-Wright's largest factory, in Buffalo, New York.

After V-J Day the Curtiss-Wright Corporation decided to discontinue its activities in Buffalo. Firmly believing in the necessity of an aeronautical research and development laboratory, C-W approached President E. E. Day of Cornell with the request that the University accept as a gift both the laboratory and the challenge to provide top-level aeronautical research. In keeping with Cornell's tradition of pineering, President Day accepted. The aviation industry supported Curtiss-Wright's choice by generously contributing an initial working capital fund of $675,000. The donors were companies long famous in the aviation field—the Aviation Corporation, Bell, Fairchild, Grumman, Republic and United Aircraft. On January 1, 1946, the Cornell Aeronautical Laboratory became a reality.

Today it stands among the leaders of the aeronautical research field. A non-profit corporation wholly owned by Cornell University, the Laboratory enjoys an international reputation. The major portion of work at C.A.L. is of the applied research type and is quite broad in scope. The Laboratory was active in the following general areas this year —aerodynamics, aircraft design, armament, electronics, flight research, guided missiles, heat transfer, helicopters, instrumentation, materials for aircraft, operations research, propulsion, crash safety, wind tunnel techniques and computer design.

To round out your knowledge of C.A.L., a series of advertisements and articles will appear in the Cornell Engineer. Watch for them—C.A.L. belongs to you!

# CORNELL AERONAUTICAL LABORATORY, INC.

B U F F A L O  N E W  Y O R K

*(This is the first in a series of articles on Cornell Aeronautical Laboratory, Inc.)*

# The Cornell Aeronautical Laboratory

*Photographs Courtesy the Laboratory*

By H. S. TOLLEY

*Department of Public Information*

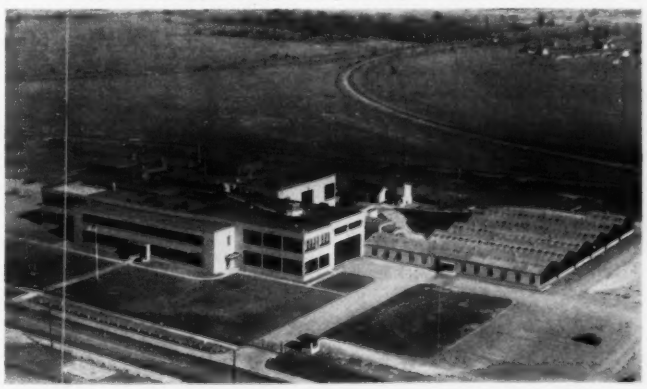
This is the history of the Cornell Aeronautical Laboratory, Inc., (C. A. L.). In effect it is the tale of an unusual wedding—the wedding of a great university with a promising industrial research laboratory. It was a hasty marriage but one of merit, as proven in the short span of but six years. The future holds even greater promise for this strange and interesting union.

CURTISS-WRIGHT RESEARCH LABORATORY
ERECTED 1942
PRESENTED TO
CORNELL UNIVERSITY
1945
IN THE INTEREST OF AVIATION AND
THE WELFARE OF THE NATION.
AN INSTRUMENT OF SERVICE TO THE
AIRCRAFT INDUSTRY · · · TO EDUCATION · · ·
TO THE PUBLIC AT LARGE.

**Shown above is the plaque of dedication of the Cornell Aeronautical Laboratories in Buffalo, N. Y.**

The laboratory of this story was born in 1942, a climax to the dreams and practical thinking of Burdette S. Wright, Vice-President of the Curtiss-Wright Corporation, in charge of the Airplane Division in Buffalo, New York. At that time, strangly enough, not one of the nation's aviation companies operated or ever had operated a true research laboratory. It is true that there were testing laboratories as adjuncts to engineering departments, but there were no research laboratories in the true sense of the word. Thus, it was that while vitally dependent on research for its advance, the aviation industry had always relied on research from outside sources. This research came largely from government organiations, particularly the National Advisory Committee for Aeronautics, and less intensely from the several university aeronautical laboratories, set up by the Guggenheim Foundation. But in the pioneer thinking of Burdette Wright there was envisioned an autonomous research laboratory, which would be organized parallel with, not subservient to, engineering, sales, and finance, and which would be expected in its own right to make contributions to aeronautical knowledge. It proved a severe battle but the dream became reality, and in 1942 the construction of this laboratory commenced. On February 11, 1943, the new Research Laboratory of the Curtiss-

**Main laboratory building showing recently constructed annex.**



1. Dr. C. C. Furnas, *Experiment in Research*, address to the American Newcomen Society, May 4, 1950, Buffalo, N. Y.

Wright Division at Buffalo, New York, was dedicated, with Dr. Clifford C. Furnas appointed as director.

### The Physical Plant

This Laboratory, representing a Curtiss-Wright investment of approximately $4,500,000, was housed in a building of about 90,000 square feet located across the street from the home plant of the Airplane Division in the eastern outskirts of Buffalo. The largest, most expensive, and most dramatice piece of equipment in the Laboratory was a large wind tunnel, costing about $3,500,000, with capabilities for testing large airplane models up to the then unheard-of speed of 750 miles per hour—about the speed of sound.

"During the remaining war years, this Laboratory grew and progressed. Admittedly, during this period its research contributions did not achieve any great significance. The effectiveness of research organizations grows but slowly. Five years is the generally conceded minimum for a new research organization to grow to a stature to produce worthwhile results. Be it said, however, that as of V-J Day the flower of Burdette Wright's dream was flourishing nicely and bore promise of fine fruit to come."[1]

With V-J Day it was but an inevitably short time until war contracts were cancelled in wholesale numbers and production activity was reduced to a mere five per cent of the wartime peak. The Curtiss-Wright Corporation did not feel financially justified in continuing to underwrite its Airplane Division Research Laboratory; and thus the union with Cornell University was conceived. To avoid loss of a vigorous research institution which could and should make significant contributions to the aircraft industry and to national defense, it was thought the Laboraory could well be converted into a public research institution, preferably affiliated with a recognized university. and to seek support from the aircraft industry as a whole, and from the government.

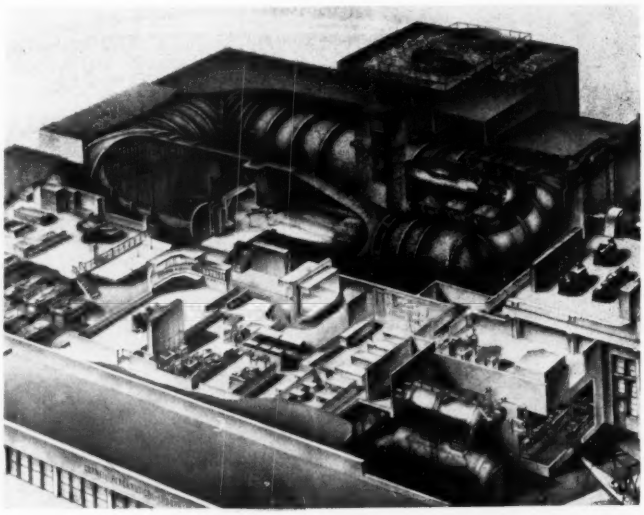
### Cornell Enters Scene

With this philosophy, Cornell University was approached in late 1945, and the idea was enthusiastically received by University President Edmund E. Day. Aided by Dean S. C. Hollister, President Day convincingly sold the case to the Board of Trustees, which acted with remarkable haste in unanimously accepting the gift, with the understanding and proviso that no University funds would be used to cover the operating expense. This was successfully accomplished through the generous pledging to the Laboratory of a $675,000 working capital fund by six eastern aircraft firms: Fairchild Engine and Airplane Corporation, the Grumman Aircraft Engineering Corporation, the Republic Aviation Corporation, the United Aircraft Corporation, the Bell Aircraft Corporation and the AVCO Manufacturing Corporation. Carlton Ward (Cornell '14 and presently a member of the Board of Trustees) devoted a great deal of effort and was very effective in bringing about this necessary support from the aircraft companies. The pledges were fulfilled, and on December 31, 1945, the Cornell affiliation became official. The early history of this unique association is well expressed by quoting Director Furnas, in a May, 1950 address to the American Newcomen Society.

"Thus one era of the existence of this new Laboratory closed dramatically and a new one opened suddenly, though without particular fanfare. On January 2, 1946, all the 600-odd employees who, two days before, had been receiving their sustenance from an industrial corporation came to work as the employees of a quasi-public research institution that had to make its own living. Although, at that time, there was work on several government research contracts in the Laboratory, which represented a substantial backlog for several months, not even the collective hope and enthusiasm of the employees could provide real assurance that this *experiment in research* would be a success. All employees were offered the blessing and aid of the new Cornell Aeronautical Laboratory in finding other, and perhaps more stable, occupation. It is thought that each one considered the matter carefully, undoubtedly with the aid of his wife, but only one man left to graze in presumably greener pastures.

"The task of keying the new Laboratory into the University structure was the cause of considerable experimentation. It was much too large a tail to hang

**Diagrammatic view showing complexity and size of the Aeronautical laboratory variable density tunnel.**



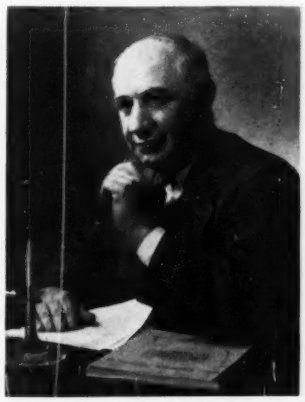
onto any part of the academic dog, and it was almost certain that, because of its wordly characteristics, it would hardly wag in unison with the parent body. Carrying its financial sustenance would have represented an intolerable overload on the University gullet known as the Budget, and, besides, the Board of Trustees had specified that this new pup must have and maintain its own feeding tube. Consequently, the Laboratory was made part of the Cornell Research Foundation, Inc., a minute, voluntary-service corporation, wholly owned by the University, which had been set up some years previously to hold patents and handle royalties that might be forthcoming from the University inventions. Though leagally sound, this was not an entirely satisfactory arrangement. However, the tolerance and good will of the University authorities made it workable, at least as an interim device.

'The two following years at the Laboratory were vital, stimulating and interesting, but admittedly, very trying. Though technical performance was good and research contracts were acquired at a pleasing rate, yet a variety of not unexpected difficulties kept the managerial skies moderately clouded. Looking back, it appears doubtful that the experiment would have been successful had it not been for the superb guidance of Dr. Arthur S. Adams, then Provost of Cornell (presently President of the University of New Hampshire) and his dynamic assistant, Dr. Richard Parmenter."

**Organization of the Lab**

It became increasingly apparent through the Cornell Laboratory's early existence, that two great problems were faced. First, the working capital grant proved to be inadequate in amount, and financial action was necessary. Second, there was no official channel for integrating the Aeronautical Laboratory's function with the complete University pattern. Consequently, two significant steps were undertaken with resulting success. These were as follows:

1. As the first step, the Laboratory was set up as a stock corporation of the State of New York, wholly owned (100 per cent of no-par-value stock) by the University. This occurred on March 4, 1948, capitalizing the Laboratory at approximately $5,000,000, and thus achieving the approximate status of a wholly owned subsidiary which is in a sufficiently autonomous position to act as an independent unit and does not involve the University in any of its business operations or financial liabilites. Acting as a non-profit corporation for some four years, the Laboratory has well proven to be self-sustaining, and presently boasts of a backlog in research and development contracts of approximately $14,000,000.



**Laboratory director**
**Dr. Clifford C. Furnas**

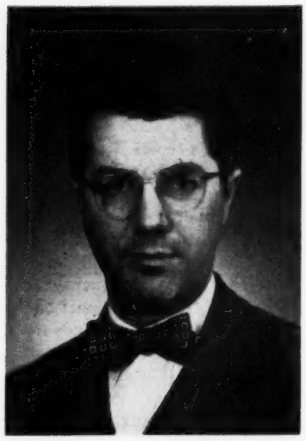
2. The second step was the creation by Cornell University of a new administrative position of Vice President for Research, with general cognizance over all contract research in the University. Dr. T. P. Wright, one time Vice-President of the Curtiss-Wright Corporation, formerly Director of the Aircraft Resources Control Office, and more recently Civil Aeronautics Administrator, assumed this position on April 1, 1948. Such a post was the obvious channel for Cornell Aeronautical Laboratory to fit into the University structure and led to the appoinment of Dr. Wright as President of the Cornell Aeronautical Laboratory, Inc., with Dr. C. C. Furnas as Director of the Laboratory and Executive Vice-President. The Laboratory's Board of Directors is interlocking with the University organization, as it contains representatives of the University administration, University Board of Trustees, and University Alumni, as well as representatives of the Laboratory and of business organizations on the Niagara Frontier. This has proven to be an ideal organizational framework for effective and harmonious collaboration between an applied research laboratory and a traditionally academic body.

Briefly, then, this is the history of Cornell Aeronautical Laboratory. In future issues of the ENGINEER, articles will be presented relating further what Cornell Aeronautical Laboratory is and does, as it strives to fulfill its motto of dedication: "An instrument of service to the Aircraft Industry . . . to Education . . . to the Public at Large."

## *Faculty Profile*

# Prof. Henry Guerlac

By M. DOUGLAS McILROY, EP '54



Once engineers at Cornell were taught straight science and technology. They were never shown how much more there is to science than textbook material. They were never shown its devlopment—where it came from or how it advanced. This was remedied in the inception of the five year program by adding to the curriculum a new course, "Science in Western Civilization," and to the faculty a new man with a new title: Professor of History of Science.

In 1946, when Professor Guerlac came to fill the position, it was a gamble whether history would be well received by engineers. But among engineers, who are not always friendly to liberal courses, it has become universally popular. Students are drawn to it now from all parts of the University, as well as from the engineering schools. It owes its success almost entirely to Professor Guerlac.

There is probably no one better fitted for this position than Professor Guerlac. He is an old hand at Cornell, born and brought up in the Cornell family of Othon Guerlac, Professor of French. He attended college here as a chemistry major and was a member of Psi Upsilon fraternity. He took both his undergraduate and master's work in chemistry.

He continued as a scientist at the Harvard Fatigue Laboratory, an organization studying the physiological aspects of fatigue in industrial operation. He worked there as a technician and as a guinea pig for tests on the results of bodily exercise. (Professor Guerlac recalls that with the exception of several long canoe trips in Canada he has had very little exercise since then.) One of the results of the experimentation of the Fatigue Laboratory was the discovery of the importance of salt in combating heat exhaustion. Out of the work of this team grew the common use of salt tablets to protect working men from heat.

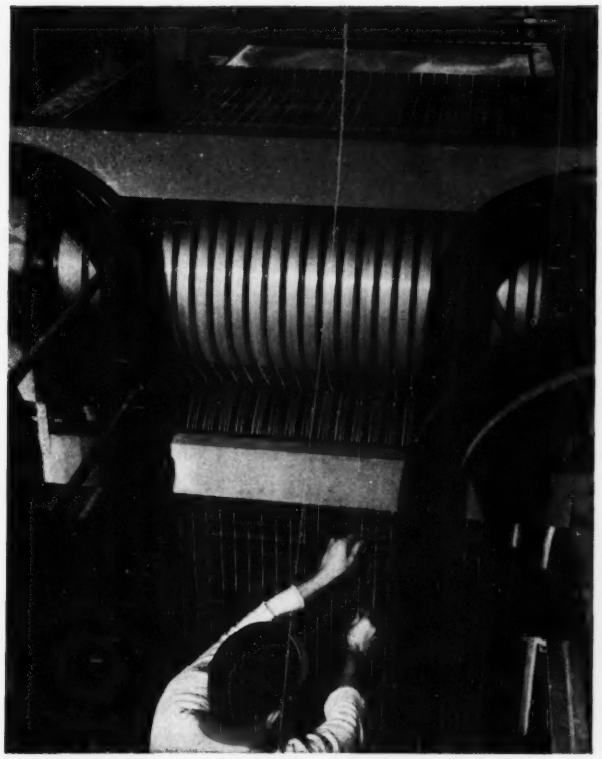
At Harvard Dr. Guerlac was given a rare opportunity to broaden his studies. He became a junior fellow of the Harvard Society of Fellows, a program in which gifted young men may study anything they wish, completely unhindered by tests, assignments or pressure to meet thesis deadlines. The group met regularly with brilliant men of all fields. Through these contacts and their free study, they received a far wider education than anyone in the usual college course could hope for.

With this chance to get a new kind of education, Professor Guerlac concentrated on humanistic subjects and became a scholar as well as a chemist. But he did not forget science. Under the influence of George Sarton, who might be called the father of the history of science, he started his research into the background of science. Although there was no requirement that the fellows work for a degree, he did a thesis in the history of science, took a battery of examinations in all the subjects he had studied informally, and received his doctorate in 1941.

From childhood Dr. Guerlac had been familiar with France. He had first traveled there at the age of two; he had been constantly exposed to the French heritage at home and had studied a year in France before attending Cornell. So it was natural for him to do his thesis on a French topic. He investigated the Ecole deMezieres, which, as ancestor of all engineering schools and the forerunner of Napoleon's famous Ecole Polytechnique, was a place where promising young noblemen were taught science, especially as it applied to military engineering. He did part of his research in the summer of 1939 just before the fall of France and brought back vivid memories of the indifference of the French military. He was allowed to visit a fort of early vintage and found it a "strongpoint" of the Maginot line, defended by a handful of World War I guns.

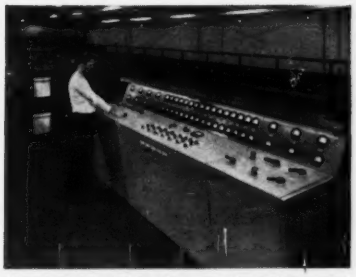
Professor Guerlac's French tastes show up in a love for wines. In fact he is quite a connoisseur, having made special visits to the vineyards of France and Italy, and he possesses a fine wine cellar. He has a large collection of writings, both ancient and modern, on wines and wine-drinking. A pet project of his was to compile a historical anthology on this happy phase of our cultural inheritance. Sharing in his non-professional interest are string quartets. Wherever he has gone, he has participated in these organizations, playing violin or viola. At the present time he meets two or three times a month with other players for an evening of chamber music.

If George Sarton is the founder of the history of science, Professor Guerlac is certainly its leading propagator. After earning his doctorate, he went to the University of Wisconsin as chairman of the Department of History of Science. He was



25 strands of steel wire start on their way to be electrolytically coated with copper, lead and brass.

Part of the 600 foot long electroforming machines where wires go through successive baths of plating solutions.



Console of controls for entire process is readily operated when necessary, even though seldom used in the almost fully automatic operation.

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Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

the department's sole member, but it was something new in college curricula. While at Wisconsin he did a great deal of work in compiling translations of ancient texts pertinent to the history of science. These grew into the *Selected Readings in the History of Science*, which is used at Cornell, Harvard, Wisconsin and other schools that now offer the subject. He has been author, as well, of several papers on the history of French science and on the impact of war upon science. Since coming to Cornell, he has inspired both liberal arts and engineering students to make a career in the field. His proteges are teaching now in other universities, thus spreading his influence beyond Cornell.

Professor Guerlac has been well recognized for his special ability. He has been elected to Sigma Xi; for three years he was a member of the council of the American Association for the Advancement of Science; he was appointed to the UNESCO commission on the History of Science; and he is vice president of the History of Science Society. He is a member of the International Academy of the History of Science, a small honorary group within the Society, and is a member of the Academy's Commission on the Teaching of the History of Science. Next summer he will attend the society's international convention in Jerusalem. He is a member of the American History Association and the American Association of University Professors. Professor Guerlac has been invited to spend his coming sabbatic leave at the institute for Advanced Study at Princeson, where he will write the first complete textbook in the history of science. It was he who was chosen to present a paper on the present state of the history of science to the ninth International Congress of the Historical Sciences in Paris in 1951.

Every class hour is a special undertaking for Professor Guerlac. He remembers from his own experience as a science student what approach will hold the interest of his audiences. He also remembers that any subject can easily grow stale with age in the hands of one teacher. He endeavors to make the presentation of each lecture fresh, to make the content different from that of last year's. He steers clear of simplifying his subject into an insult to the intelligence of his students. But while presenting a high-level course, he keeps excellent contact with his audience; they are always with him, and he is always sensitive to their reactions. The lectures have become well known for their vigorous, jaunty delivery as well as for the fascinating subject matter Professor Guerlac has chosen to include.

Professor Guerlac, still a young man, has become a leader in his field. He is enthusiastically involved in spreading historical sense, in his own words, "another dimension of thought," among the minds of his students. When they leave his class, they go impressed by a dynamic teacher and awakened to the heritage of scientists.


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| 22,000 lbs. | |
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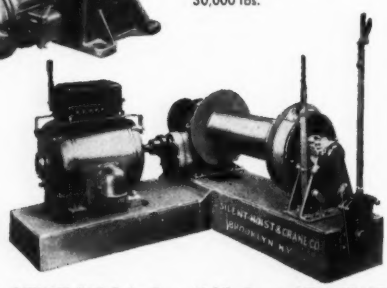


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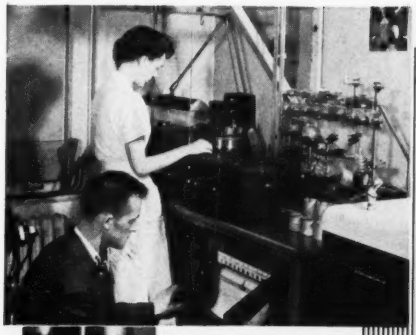
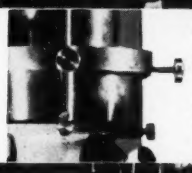
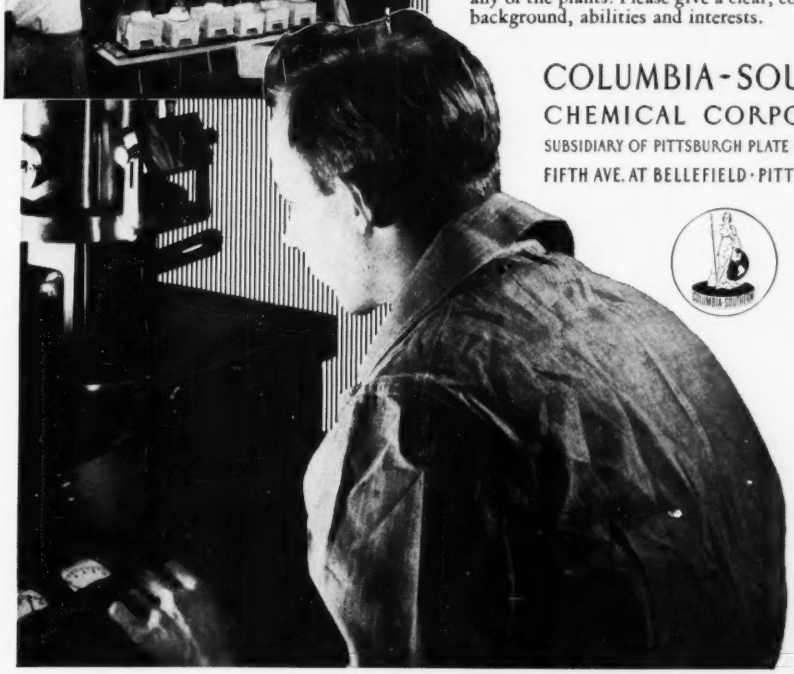




Making an analysis with the infra-red Spectrophotometer.

Testing action of Perchlorethylene on various metals.



Focusing the Electron Microscope on a chemical sample to be photographed.

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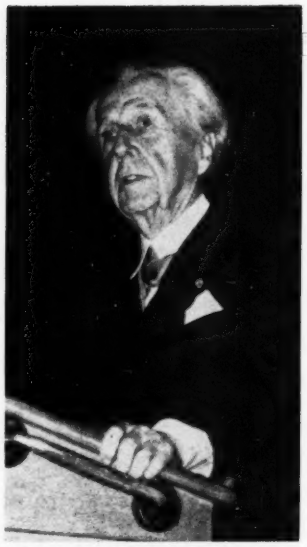
# Frank Lloyd Wright in Ithaca

"Nature has endowed Cornell very, very well, but how man has fouled is up!" Thus spoke Frank Lloyd Wright, long a controversial figure in American architecture, on his recent visit to the Cornell campus.

Wright lamented, "It is a piteous thing that boys with little pink slips should be let loose to characterize society for hundreds of years." Alluding to religious ideas, he stated that the source of expression should be within the individual, that organic architecture is not possible if the nature of the thing is not in the mind of the architect. Science and knowledge of machinery can be taught, "but artists are born." Only a few dozen really good architects are needed in the United States, Wright feels, but "we won't get them from education." Artists need experience and the opportunity to grow, and a boy should have the chance to do what he likes before he decides upon a formal university education.

Wright had ample opportunity to display his ready wit in the question period following his talk. When asked how industrial design relates to the philosophy of organic architecture, Wright said there is no distinction; that a designer is a designer, good or no good, and that calling a man an "industrial designer" is like "spitting on the apple and polishing it." He said of Buckminster Fuller, that, although Fuller is one of his best friends, he considers his scientific approach not to be that of the artist and he wouldn't live in a building designed by Fuller; of Le Corbusier's theory of vertical construction, Wright stated it is the antithesis of organic architecture, and that it has never occured to Le Corbusier that there is a third dimension. Asked what he thought of young women in architecture, Wright replied whimsically, "I think of them in architecture as I think of them everywhere," and then added, "I see no reason why women should not be useful members of the profession."



Frank Lloyd Wright speaking in Bailey Hall on November 6

One listener queried, "How can houses in a crowded city incorporate organic architecture?" Wright answered, "That's why I think you should all go to the country. The city is out-dated, except that man is a gregarious animal and woman peculiarly so." Much amusement resulted from his reply to the question of what kind of United Nations building would Wright have designed, to which he answered, "What? For this price of admission!" Further questions concerned the matter of expense of organic architecture, which Wright feels is the only kind in which to live, "if you want to live right;" the intrinsic meaning of structures; the importance of knowing what is right and practicing that ("Individualism is not license to do what you want; democracy presupposes consci-

(Continued on page 42)

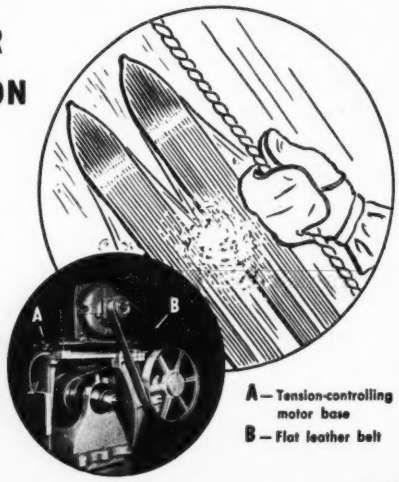

FOR THE LONG PULL...

IT'S LEATHER PLUS TENSION CONTROL

On the ski tow it's the leather grip of your ski mittens plus tension controlled by your hands that helps you get the most out of power.

In modern industry, the UNI-PULL short center drive uses leather belting and tension control for long, trouble-free power transmission.

That's part of the reason why today there are more leather belt drives in industry than ever before.




A — Tension-controlling motor base

B — Flat leather belt

AL-35

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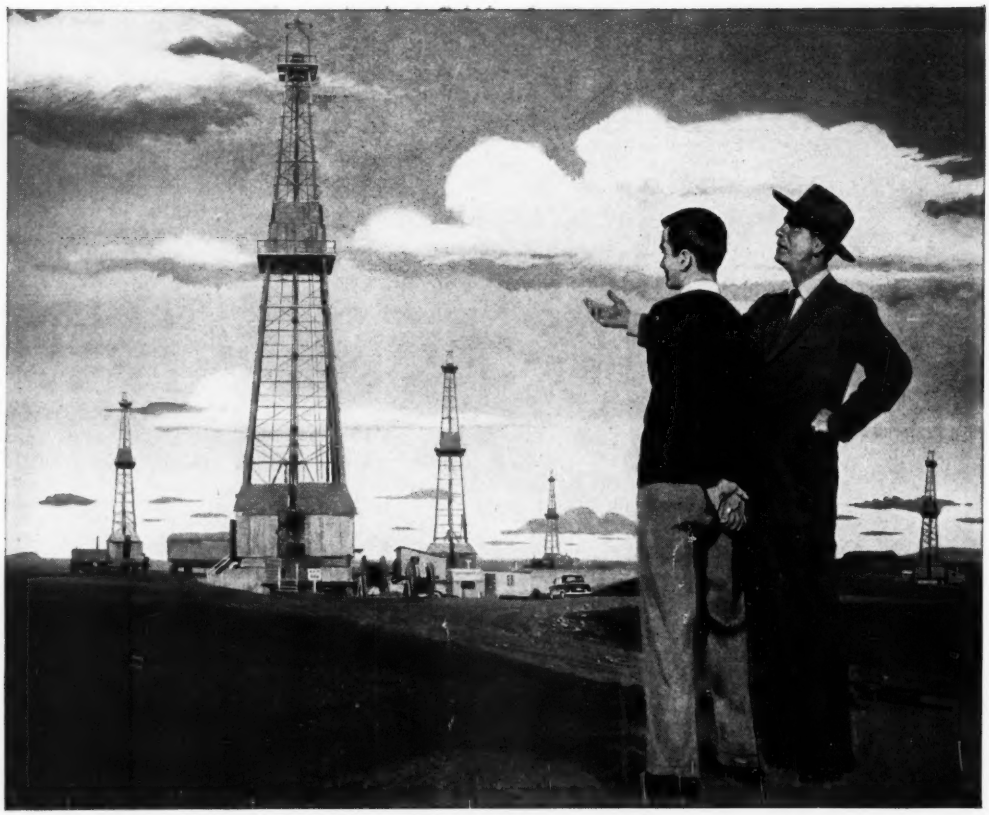

# To a Young Man who wants "Room to Grow"

That's one of the attractions of the oil business as a career: big and substantial though it is today, prospects are that it has a long way yet to grow.

The discovery of new sources of petroleum and new *uses* for petroleum has gone ahead faster during the past five years than in any other comparable period. Phillips Petroleum Company gross income increased from $222 million in 1946 to $611 million in 1951. And 8,300 new job opportunities were created.

The *primary* business of Phillips Petroleum Company is producing, refining and marketing fuels and lubricants. Yet Phillips is one of the most widely diversified oil companies, and we offer opportunities for the technical graduate in many other fields: development of chemical derivatives from petroleum, ammonia and sulfur compounds, rubber synthesis, atomic research, geophysics and analytical techniques.

If you're looking for a "career with a future" we invite you to write to our Employee Relations Department for further information about opportunities with our company.

Phillips 66

**PHILLIPS PETROLEUM COMPANY,** Bartlesville, Oklahoma

# Note for a faculty member's briefcase!

Recently we had the pleasure at General Motors of welcoming 19 faculty members from leading engineering schools to Detroit.

This was part of our continuing effort to discover ways in which GM can be of help in furthering the growth of engineering education in America.

And their professors informed us that they would welcome information on General Motors employment opportunities which they could pass along to their students.

In the thought, therefore, that other faculty members may share their opinion, we are publishing this message.

So we would like you to know these few simple facts about GM job opportunities.

1. They are broadly assorted—fitting a wide range of talents—from the pure scientist to the young man who sees in his engineering training a fine background for production or management work.
2. They cover a wealth of subjects—from chemistry and chemical engineering to mechanical and electrical engineering, from metallurgical engineering to industrial engineering.
3. They offer reasonable advancement for the diligent and ingenious mind. For the industrial climate at GM is conditioned by a traditional respect for the engineering point of view. Witness the number of key GM executives in both divisions and top management who began their careers as engineering graduates on GM drafting boards.

And we would like you to feel free at any time to write us, or ask our College Representative, who periodically visits your campus, any detailed questions on the subject of GM jobs for your talented students.

**GM POSITIONS NOW AVAILABLE IN THESE FIELDS:**

**Mechanical Engineering**
**Electrical Engineering**
**Metallurgical Engineering**
**Industrial Engineering**
**Chemical Engineering**

**GENERAL MOTORS**

**Personnel Staff**
**Detroit 2, Michigan**

## Frank Lloyd Wright

(*Continued from page* 38)

ence"); and the purposes of the sort of cultural education offered in his apprenticeship school.

Wright spoke to a large group of interested listeners the following day in the East Lounge at the Straight. He elaborated on the sort of education he feels important for young people. In the formulation of his own philosophy of architecture he considers of value the writings of every poet he has read, particularly Goethe, the Spaniards, and Wordsworth, since every poet "has preached organic architecture." Wright stated that most graduates of architecture and engineering schools don't know the facts of life; that young people should go out and work to get the bugs out of their system and then go back to college. Again referring to college architecture, he commented, "Doctors can bury their mistakes, but architects cover them with ivy." Questioned about various personalities in architecture, Wright's opinion varied according to whether the individual subscribed to his own style of architecture. One of the architecture students later remarked, "He's a god, and he knows it."

Wright first received recognition from other countries. The Imperial Hotel in Tokyo, Japan, was the first building to bring him world-wide fame. His practice, which began in Chicago in 1893 after a formal engineering education at the University of Wisconsin, has brought him many honors from other countries as well as the American Institute of Architects' gold medal in 1948 and an honorary doctor of fine arts degree from Princeton.

To the Cornell architects, Wright's architectural principles seemed a little "fuzzy" in some respects; just as some of his ideas seemed perhaps a little grandiose to his Bailey Hall audience (Wright's reply to one question of whether he would subscribe to a universalistic philosophy of architecture in which design of all life would be the architect's pregrogative, was that "Sculpture, music, and poetry cannot give culture apart from architecture"), some of his critical remarks, as of cities being outmoded, seemed to lack the support of alternative suggestions.

Kent commented that the activity of Wright's mind was remarkable in that he had a way of storing up miscellaneous bits of information he might not use for a number of years; just before he left the Ithaca airport, Wright inquired about the length of a runway, saying he was thinking of designing an airport. The modern house on Triphammer Road, on the route to the airport pleased Wright, who commented, "There's a piece of me," when he caught sight of it.

Architects and other Cornellians enjoyed the visit of Frank Lloyd Wright. We may hope the feeling was mutual and be rather gratified that Mr. Wright saw fit to remark casually to Dean Mackesey that "this was one of the good groups he'd talked to," in his visits to many university campuses.

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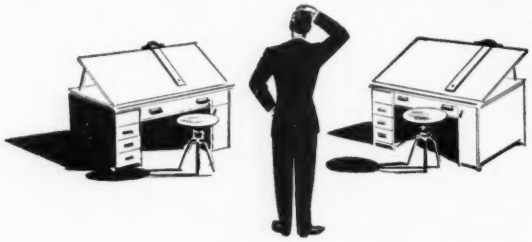


# Pick for the Long Pull

In times like these, it's all too easy to "pick the wrong horse."

You know that engineering jobs are easy to come by today—that there are more openings than there are trained people to fill them. From where you sit, that sounds pretty good, doesn't it?

*But think a minute!*

We've had periods of emergency before. But did they last forever? How about 1918—or 1945? Inevitably, many of today's lush job opportunities will dry up sooner or later. And jumping into just *any* job come graduation may well turn out to be a case of "picking a wrong horse."

***That's why it's a smart move to ask yourself a few questions first—things like these:***

**Q. *How shall I decide which Company to join?***

Ask yourself if a world-wide reputation as an *engineering* company — well-trained, experienced and highly skilled—isn't part of what you're looking for. And isn't a *production* organization the rest of it? That's what you'll find at Goodyear Aircraft.

**Q. *What will a cutback in defense production mean?***

One answer could be this: At Goodyear Aircraft—now 100% busy on defense and other contracts—you'd be working for a major division of the world's largest rubber manufacturing company. Goodyear's aircraft operations kept going after 1918—built to huge size during World War II—*and kept going after 1945.* War work became peace projects; skilled workers *stayed* with the world-wide Goodyear organization.

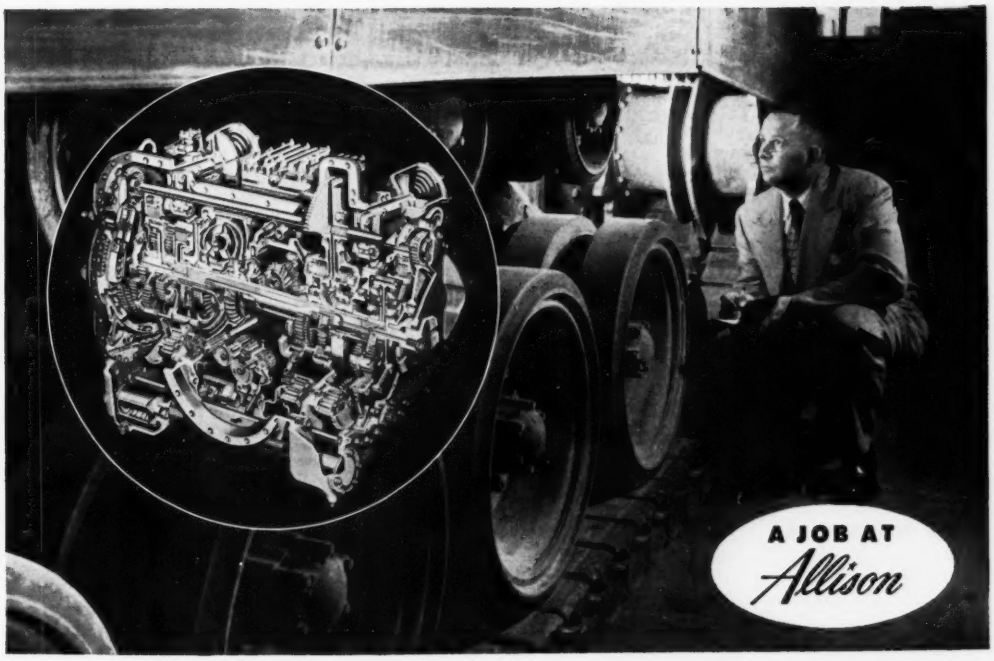
**Q. *What are the present opportunities?***

Today, Goodyear Aircraft is working intensively on defense projects ranging from building Navy lighter-than-air through producing a long list of components for military aircraft to construction of analog computers. Also work is in progress on plastics, metals, other materials—in aeronautics, electronics, hydraulics —materials and fields with wide industrial application in normal times.

**Q. *What next?***

YOUR BEST ANSWER is—"investigate Goodyear Aircraft"—a *good* place to work today—and for the long pull ahead. Submit a brief resumé of your experience and qualifications or write us for an application blank and further information. Prompt consideration is assured. Address Salary Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio.

**GOODYEAR**—*The Company With Complete Coverage of the Aeronautical Field*




● **ALTON R. PATTERSON,** who received his M.E. from the University of Oklahoma in 1950, is another engineer at Allison who has a responsible position in an advanced field of science and mechanics. He is responsible for the application and best usage of hydraulic transmissions, like the CD-850 shown in the inset, to tanks and other heavy military vehicles.

These big and complex Allison Cross-Drive transmissions do more than their name implies. Along with the functions of a Torqmatic Transmission, they also brake and steer the vehicle. With a single lever, a tank driver is able to maintain finger-tip control. To accomplish this exacting assignment, some transmissions require as many as 5000 parts, including hydraulic drive, planetary gearing, steering and braking mechanism and hydraulically-operated clutches and bands.

Pat's job is to insure the proper mating of transmission to vehicle, requiring him to work closely with manufacturers and proving grounds all over the country. One of the problems with which he is now working is a track vibration analysis and resolution of the effects of the vibration on the transmission. The result of his work will contribute toward better performance of a military vehicle, longer life for its parts and an improved product for our national defense. And, meanwhile, Pat is accumulating skill and experience in a field where the commercial possibilities have hardly been scratched. He is building his own future while working to insure the peaceful future of his country.

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# TECHNIBRIEFS

Saving in time, money, and gas and greater safety are reported for an automatic acetylene-air gas torch known as "Torch-O-Matic. The pistol-shaped torch lights up at a squeeze of its trigger and shuts off on release. This eliminates separate operation and equipment for relighting, manual valve adjustment, pumping or priming, and warm-up. It is said to be especially well-suited for intermittent, on-again, off-again work as is found

—*Velocity Power Tool Co.*

**The "Torch-O-Matic" produces acetylene flame at squeeze of trigger.**

in plumbing, heating, piping, refrigeration and sheet metal jobs.

Squeezing the spring-loaded trigger simultaneously opens the torch gas valve and sparks the heavy-duty flint for ignition. The trigger can also be locked open for continuous flame. The torch weighs only twelve ounces and provides instantaneous heat up to twenty-eight hundred degrees. Various combustion tubes permit the use of the torch from heavy to finest precision work. In cost it is reported to compare with older types of torches.

## Radiation Source

A new, powerful radiation source has recently been installed at the Knolls Atomic Power Laboratory. Twice the world's present supply of radium, which if obtainable would cost one-hundred and thirty million dollars, would be needed to equal in intensity the rays from this source. The radiation causes a blue-white glow in the nine-foot depth of protective water under which the source is kept.

The source consists of about two and a half pounds of a radioactive form of cobalt, cobalt 60. The radiation is gamma rays or high energy x-rays. The cobalt is kept in ten cylindrical holes in a steel plate. Remote control devices permit them to be handled, and allow test samples to be placed in position around them. The source is rated at 3400 curies, which means about fifty watts of energy are constantly being transmitted to the water. Light is caused by "Cerenkov" radiation, an interaction between gamma rays and the atoms of water.

The cobalt is created by bombarding ordinary cobalt 59 with neutrons. After five and a third years, half of a given amount of cobalt 60 is converted to an isotope of ordinary nickel, gamma rays being given off in the process.

The Laboratory will use the new installation in connection with its work on the design and construction of atomic power plants. Physical properties of many materials in such a plant may be altered by the powerful rays generated in the reactor. By lowering samples of these materials into the water, these effects can be studied on a small scale. This method supplements tests of irradiation on materials done in nuclear reactors.

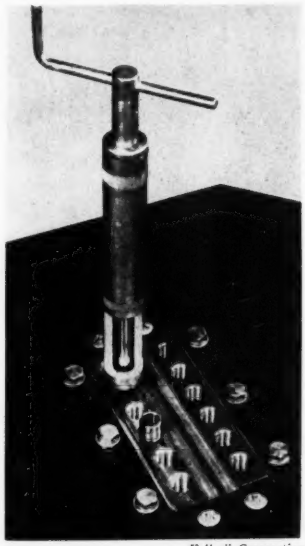
## Teflon Paint

A new type of paint is now on the market whose name is equaled only by its seventy-five dollar a gallon cost, "Teflon" polytetraflouroethylene finish. It possesses a unique property, however, that will guarantee sales to its maker, E. I. Du Pont, even at that price. Practically nothing will stick to it. It is being used as a coating of bread baking pans, so that the pans require no greasing before each bake. It may also be of great aid in packaging and other industries where engineers have long been concerned with the problem of glue sticking to machine parts, preventing accurate and efficient operation.

The finish is a water suspension of a plastic which has extremely high chemical, heat, and moisture resistance. This plastic is also used to prevent corrosion of equipment and as electrical wire insulation. It is an inherently expensive finish to produce and will probably never reach a price level that would qualify it as a consumer product. However, consumers may benefit directly in many possible applications, especially in kitchenware.

## Wire Thread Inserts

Stainless steel wire thread inserts are solving two problems in aluminum castings. These liners, developed by Helicoil Corporation,



—*Helicoil Corporation*

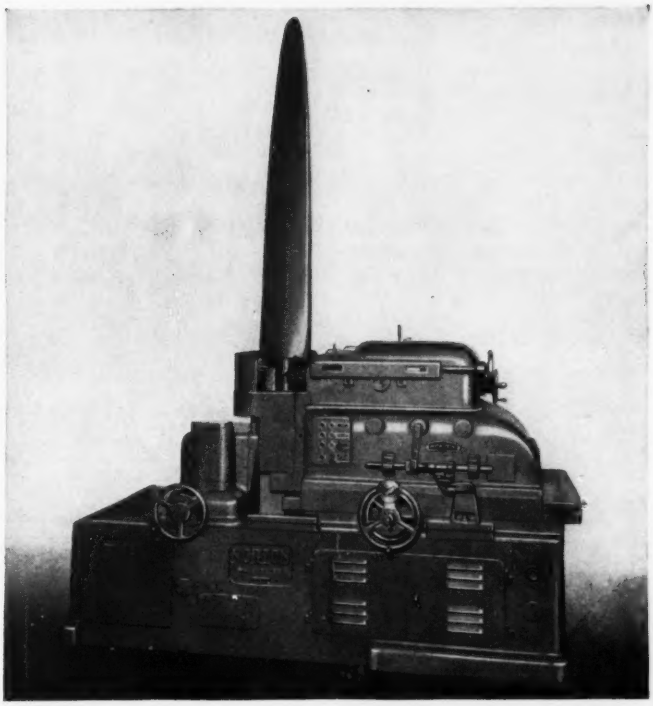
**Stainless-steel wire thread inserts reinforce copper "fish tails" projecting through a transformer panel.**

have added new strength and durability to threads in the soft metal. The low-loading characteristics of threads tapped directly posed prob-

(*Continued on page* 48)

# What Is this Machine?

- ☐ *a vertical miller*
- ☐ *a grinding machine*
- ☐ *a broaching machine*
- ☐ *a contour shaper*



It is a grinding machine — specifically, the new Norton Propeller Blade Hub Grinder, used to grind the external surfaces of the hubs of aircraft propeller blades

### *A Typical Norton Development*

This specialized Norton machine brings unusual efficiency to propeller grinding operations. As shown, the propeller blade is held *vertically* — by a workholding fixture on a work spindle with an anti-friction bearing — a new departure that avoids the errors normally caused by deflection when the blade is held *horizontally*, as in conventional methods.

The new Norton grinder has many other improved features adding up to greater speed, accuracy and simplicity of operation. And it requires considerably less floor space than do horizontal machines adapted for the same purpose.

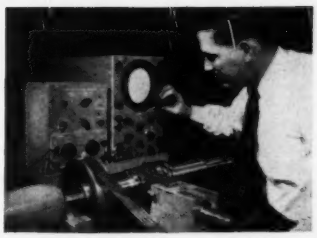
### *The Broadest Line*

The Norton line of grinders and lappers is the most complete offered by any single manufacturer. It runs from small machines for the tool room to high precision, high volume units for heaviest production line duty. Equipped with Norton abrasive wheels these machines form unbeatable combinations for efficient, economical grinding.

### *To Future Technicians*

As the world's largest manufacturers of abrasives and abrasive products, Norton supplies basic tools to all industry. To young men now planning ahead, a career with Norton offers exceptional opportunities for "making better products to make other products better."

***Free Booklet*** describes and illustrates representative types of Norton grinding and lapping machines. Write for your copy.



Guy D. Metcalf, B. S., E. E., Worcester Polytechnic Institute '49, checks smoothness of master cam spindle with specially designed electronic equipment — in connection with his work on Norton cam and contour grinders.

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## Technibriefs

(*Continued from page 46*)

lems both in manufacture and maintainance; aluminum threads were often damaged in normal assembly, and became prematurely worn by regular removal of parts for inspection or adjustment. Use of the inserts thus cuts production salvage costs, and at the same time, aluminum threads are completely shielded from wear in service.

### Electrical Optical Brain

North American Aviation has developed an electrical optical "brain" for use in obtaining information on how fast an airplane lands. The instrument, Touchdown Rate of Descend Indicator, known as TRODI, has proven itself aboard the carrier Midway. All new type Navy planes must be tested for rate of descent before being put in operation. This information is needed in measuring the rate of descent aircraft structures can stand, evaluating automatic and manual landing systems, and training student pilots.

—*North American Aviation, Inc.*

**The new instrument TRODI (on pedestal upper left) is shown here in operation aboard the USS Midway during recent carrier suitability tests for the North American XFJ-2 Fury Jet.**

Previously, the descent of incoming planes was recorded with cameras, and the photographed data was not available for days. With TRODI's rapid calculation, the data is ready for the pilot as soon as he steps from the cockpit. TRODI sends out two parallel beams of light, thin vertically and wide horizontally. They are one foot apart. A mirror system on the incoming plane cuts the top beam, reflecting the light back to a photocell, which starts an electric charge into a condenser. The descending plane then cuts the lower beam, which stops the charge going into the condenser. The charge on the condenser is quickly translated from voltage to rate of descent in feet per second.

### Ultrasonics

A new use for ultrasonics, or inaudible high-frequency sound waves has been found by General Electric for industrial cleaning of small parts. The high-pitched sound waves are directed through a liquid solvent into the crevices, corners, and holes of the parts. This makes the cleaning action of the solvent much more effective in removing grease, dirt, shavings, and other particles. The compactness of ultrasonic cleaning equipment, in addition to its more effective and faster cleaning, makes a great saving in floor space. The new method is not necessarily limited to small parts.

This is one of the first really practical applications for ultrasonics. It has also been proposed for use in killing insects and mixing paints, but to date these uses have not proved commercially feasible.

### Flame-retardant Laminate

A new flame-retardant laminate has been devoloped by Synthane Corp. The new material provides increased safety by reducing afterglow effects. A test procedure, utilizing a strip of the laminate alternately exposed to the flame of a Bunsen burner for fifteen seconds and removed for an equal length of time, proved that the flame would extinguish itself completely after each cycle and within sixty seconds after the sixth cycle.

This laminate is particularly suited for use in printed circuits and in other electrical and aircraft applications. It is no different from ordinary laminates either in machining properties or electrical values.

● LEROY* Lettering equipment is standard in drafting rooms everywhere. No special skill is needed for perfect, regular lettering and symbol drawing. There are LEROY templates in a variety of alphabets and sizes, as well as for electrical, welding, map, geological, mathematical and other symbols that the draftsman needs. *Trade Mark®

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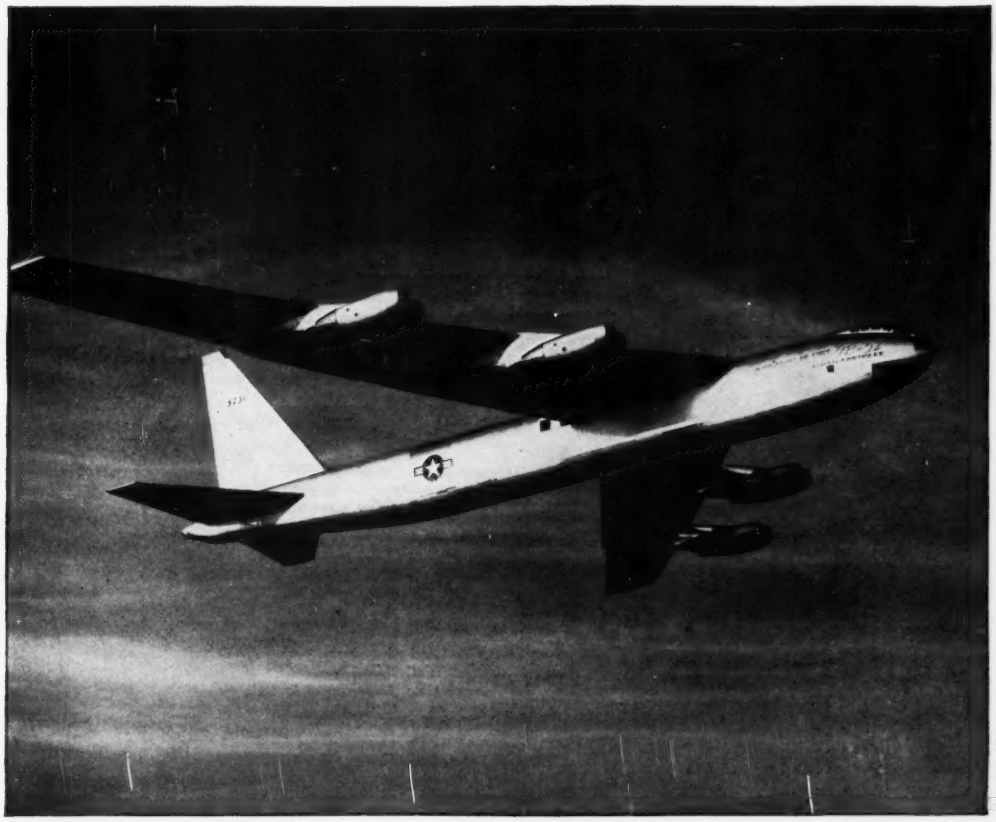

## This is the Boeing team's jet heavyweight

Here is a flight shot of the giant Boeing B-52 Stratofortress. An eight-jet heavy bomber, the Stratofort is a fast, husky teammate to the B-47 Stratojet medium bomber. It's 153 feet long, measures 185 feet from wing-tip to wing-tip, and is powered by eight Pratt & Whitney J-57 engines. Speed and other performance details are carefully guarded secrets.

This Boeing jet-bomber team is another example of the trail-blazing that, for 35 years, has kept Boeing engineers at the head of the design parade.

If you measure up to Boeing standards, you can share this Boeing prestige. You'll work with men renowned in their fields on such challenging projects as guided missiles, nuclear-powered aircraft, and the exploration of supersonic flight.

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**Plan *now* to build your career as a member of Boeing's distinguished Engineering personnel after graduation. Boeing has present and future openings for experienced and junior engineers in all fields, for aircraft**

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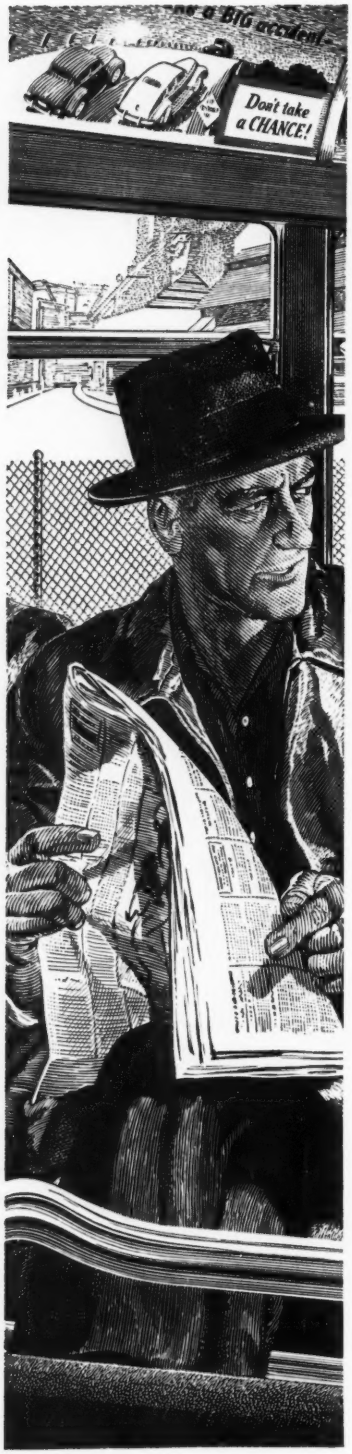



# "Look what *I'm* reading!

*"No kidding, Ed . . . the* EDITORIAL *page!*

"You know me, Ed...I'm strictly a sports page guy. But when I was home in bed last week with that blasted head cold, I didn't have much to do but read the paper.

"So, with time to burn, I looked at everything but the recipes . . . which is Marge's department, anyways. And, Ed, what I read in those editorials made me mad enough to forget I felt punk.

"One was about *'Creeping Socialism'*. It told what's going on right under our noses . . . a lot of undercover work to turn us into a bunch of spineless dummies, instead of free citizens.

"It warned how we *could* lose some or all of our Freedoms . . . you know, free speech, press, vote and religion. *And* the right to work or live where we please. This editorial showed how other people abroad have let socialism, then communism, take over and make slaves out of them. And all the time these people thought all they had to do was let Government *'take care of them'*. And it sure did!

"Since then, Ed, I've been reading *all* the editorials and articles . . . in newspapers *and* magazines. Been learning to think, too. And to talk things over with my neighbors and the fellows we work with down at Republic . . . things like government ownership and wasteful spending that can bankrupt a whole nation and all its citizens. Yep, I've been learning to appreciate the Freedoms that *we* have and other people *don't*. And best of all, yesterday I REGISTERED TO VOTE. . . *and my wife did, too!* That's the BIGGEST American Freedom of 'em all, and like a dope I've been too careless to protect my own and my family's interests with a ballot!

*"Funny, isn't it? From a cold in the head, I got sense in the head."*

## REPUBLIC STEEL

**Republic Building • Cleveland 1, Ohio**

***Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free*** . . . an America whose stores are laden with the many fine products of a free Textile Industry. *And, through Textiles, Republic serves America.* Long-wearing, comfortable dress and suit materials . . . gay prints . . . smart drapery and upholstery fabrics . . . all are spun, dyed and woven on machinery made of carbon, alloy and stainless steels . . . much of them from the mills of Republic. New, almost magical synthetic fibers are today developed and produced with equipment largely made of stainless steels, notably Republic's famed ENDURO. Thus steel does its part to help keep Americans comfortably and smartly clothed the year round.

* * *

*For a full color reprint of this advertisement, write Dept. H, Republic Steel, Cleveland 1, Ohio.*

# "I needed to 'Find' Myself— that's why I picked Allis-Chalmers,"

**says A. J. MESTIER**

*Massachusetts Institute of Technology Sc. B.—1943*
*and now Manager, Syracuse District Office*

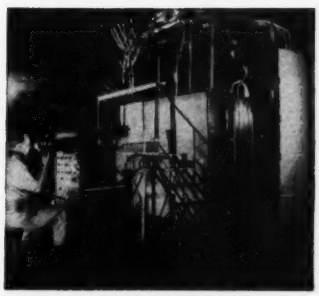
"I WAS LOOKING for an engineering job, but I wasn't very sure just what phase of this broad field would interest me most. I didn't know whether I wanted straight engineering, sales engineering, production or some other branch of industrial engineering.

"Allis-Chalmers Graduate Training Course gave me a means of working at various jobs—seeing what I liked best—and at the same time obtaining a tremendous amount of information about many industries in a very short time."

### Experience Typical

"My experience is typical in many ways. I started the Graduate Training Course in 1946, after three years in the Army. My first request was to go to the *Texrope* V-belt drive department. From there I went to the Blower and Compressor department; then the Steam Turbine department. By the time the course was completed in 1948, my mind was made up and I knew I wanted sales work. I was then assigned to the New York District Office and in 1950 was made manager of the Syracuse District. The important thing to note is that all Allis-Chalmers GTC's follow this same program of picking the departments in which they want to work.

"Best of all, students have a wide choice, for A-C builds machines for every basic industry, such as: steam and hydraulic turbine generators, transformers, pumps, motors and other equipment for electric power; rotary kilns, crushers, grinders, coolers, screens and other machinery for mining, ore processing, cement and rock processing. Then there is flour milling machinery, electronic equipment and many others."

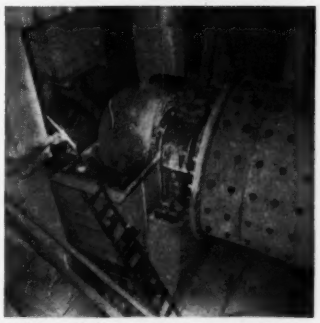


**Taking** surge voltage distribution tests on power transformer in A-C shops with miniature surge generator and cathode-ray oscilloscope.

### A Growing Company

"In addition, new developments and the continuing growth of the company offer almost endless opportunities for young engineers.

"From my experience on the Graduate Training Course, I believe it is one of the best conducted in the industry and permits a young engineer to become familiar with a tremendous variety of equipment—both electrical and mechanical—which will serve him in good stead in his future profession."



**Ball Mill** grinds ore for large copper producer. Same type of equipment from Allis-Chalmers pulverizes much of nation's cement.

*Texrope* is an Allis-Chalmers trademark.

**ALLIS-CHALMERS**

*For information call the Allis-Chalmers District Office in your locality or write to Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin*

# COLLEGE NEWS

The New York State Building Code Commission has named Prof. George Winter, head of the Department of Structural Engineering, to an advisory panel on its code for multiple dwellings. Prof. Winter's research has been chiefly on the use of light-gage steel in building.

The state commission aims to replace present municipal codes, often widely varying, contradictory, or out of date, with one unified code for the entire state.

By stating standards in terms of performance rather than detailed specifications, the commission hopes to expedite the use of new materials, methods and assemblies and to limit the ingenuity of the designer as little as possible.

Nearly fifty planning and zoning officials from New York State attended a three-day Municipal Training Institute in Statler Hall, beginning November 12. The College of Architecture was one of four agencies which planned the institute.

Dr. George B. Robinson, president of the New York State Federation of Official Planning and Zoning Boards, another sponsoring agency, presided at the first meeting. He formerly taught at Cornell in the College of Agriculture.

The delegates were welcomed by Dr. F. F. Hill, university provost. Dean M. P. Catherwood of the School of Industrial and Labor Relations spoke on "Human Aspects of Planning."

The rest of the program consisted of panel discussions on problems connected with public relations, school planning, automobile parking, highway planning and zoning.

School board presidents from Tompkins and contiguous counties were invited to attend the panel in school planning problems. Panel members were Dr. James E. Allen, deputy commissioner of the state education department; Prof. Clyde B. Moore, treasurer of the New York State School Boards Association; and Dean Thomas W. Mackesey of the College of Architecture.

Participants in other panels included David R. Levin, of the U.S. Bureau of Public Roads ,Bureau of Highway Planning. Other Cornell staff members on the program were Prof. Elmer S. Phillips, chairman of the Town of Ithaca Planning Board; Prof. E. A. Lutz, School of Business and Public Administration; Prof. John W. Reps, Department of City and Regional Planning; and Stillwell Brown, manager of the Rural Radio Network.

The institute is an educational institution chartered by the Regents of the University of the State of New York and administered by officers and members of the state Conference of Mayors and other Municipal Officials.

## Classroom Television

Cornell's new classroom television was demonstrated to approximately 100 physicists during a meeting of the New York State section of the American Physical Society at the University on October 17 and 18.

Prof G. E. Grantham, one of the Cornell faculty members who uses the TV setup, explained the technique. The television project was established this fall for freshman and sophomore physics courses. Experiments are televised from the instructor's desk to viewing screens visible from all corners of the room. The project is especially useful in showing microscope images.

In the Society's opening session on Friday morning, Prof. Hans A. Bethe of Cornell and Dr. L. H. Thomas of the Watson Scientific Laboratory spoke. Professor Bethe discussed "The Fundamental Particles of Physics" and Dr. Thomas talked on "The Use of Large Scale Computing in Physics."

Prof. P. P. Kellogg of Cornell spoke Friday evening in Statler Hall on jungle acoustics and methods of recording bird songs, illustrating his talk with bird song recordings produced at Cornell.

Saturday afternoon was devoted to visits in the University's teaching and research laboratories.

## Five-Year Schools Conference

The second annual conference of Five-Year Engineering Schools was held in Olin Hall, on November 6 and 7. Participating were faculty

(*Continued on page 54*)

**Professor Guy E. Grantham makes use of a small television camera for a freshman physics class, where TV has recently been introduced as an educational aid.**

Longer lasting batteries, plus a unique power saving switch, give this RCA Victor personal radio 10 times the playing life of previous models.

# New Personal Radio...plays 10 times longer

About the size of the average book, this new Personal radio—developed through RCA research and engineering—offers new convenience and economy to those who want a light, beautifully streamlined, long-lasting instrument.

Secret of its long life is a new dry cell "B" battery—used in combination with redesigned "A" batteries to create a more lasting power source. Additional life is given by a unique switch, for use in areas where radio reception is strong, which reduces the drain on the batteries, and adds up to 30% to their lives. RCA Victor's new receiver plays *instantly*, without needing to warm up, has an automatic control to keep the sound volume even, and can be had in six rich colors.

**Development of this compact radio is another example of RCA research and engineering at work for *you*. RCA research means better quality and performance from any product or service of RCA or RCA Victor.**

* * *

*See the latest in radio, television, and electronics at RCA Exhibition Hall, 36 West 49th Street, N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.*

**RADIO CORPORATION OF AMERICA**

***World leader in radio—first in television***

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**Graduate Electrical Engineers:** RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
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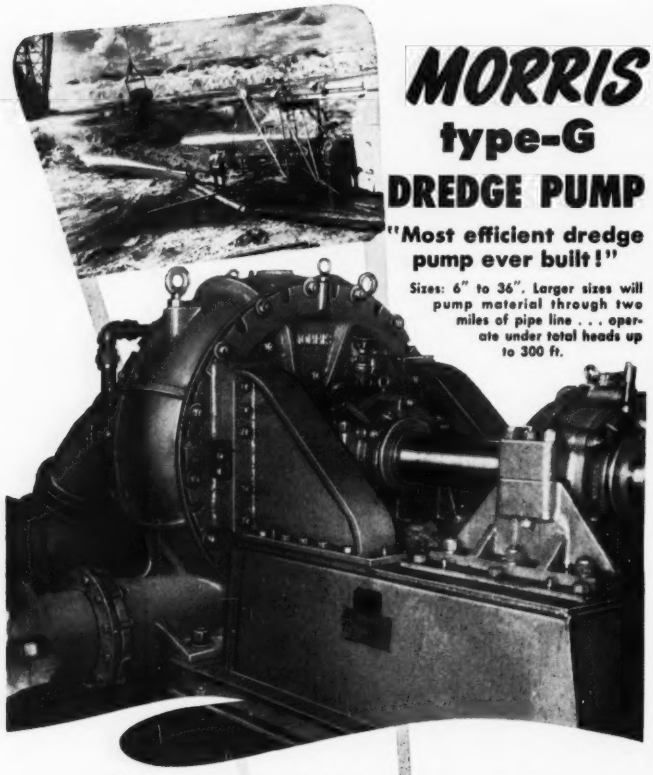
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

*Write today to College Relations Division, RCA Victor, Camden, New Jersey.*

**Also many opportunities for Mechanical and Chemical Engineers and Physicists.**



**MORRIS**
**type-G**
**DREDGE PUMP**
**"Most efficient dredge pump ever built!"**

Sizes: 6" to 36". Larger sizes will pump material through two miles of pipe line . . . operate under total heads up to 300 ft.

## Long life under high output due to efficient design and construction

*Specially designed bearings*—Stand up under all loads, hydraulic or mechanical, encountered in severest types of dredging work. Anti-friction, self-aligning roller bearings on sizes 6" to 16" —heavy Kingbury bearings for pumps above 16".

*Patented pressure balanced impeller*—Lasts longer—all parts wear evenly. Shroud on suction side is larger in diameter —balances casing pressure, decreases wear.

*Other superior Morris features*—Volute-type casing. Interchangeable liners on hub and suction sides. Easily accessible stuffing box. Vibration-free, extra-large, high-grade steel shaft removable through suction side of casing.

The experience of 87 years in the designing and building of pumps is at your disposal. Let our engineers help you select the exactly right pump for your particular needs. No charge or obligation.

JOHN C. MEYERS, JR., E.E.
Executive Vice-President

**MORRIS MACHINE WORKS**
**Baldwinsville, N. Y.**

**MORRIS** *Centrifugal Pumps*

**Branch Offices in Principal Cities**


## College News

(*Continued from page 52*)

representatives from the University of Louisville, University of Minnesota, Ohio State University and Cornell University. As a result of the conference the curriculum at Rice University was recognized as a genuine five-year program, while Dartmouth's curriculum was recognized with reservations. Next year's convention will therefore include representatives from these latter schools.

Positive agreement was reached among the representative schools that the five-year program has proven itself and is here to stay. This feeling was much stronger than similar sentiment at the 1951 conference held at Ohio State. With regard to the future status of such programs, the conferees agreed that more schools would eventually adopt the longer curriculum. At the same time, it was agreed that not all engineering schools should adopt the five-year program, since many do not have adequate facilities to install the more complex course. A positive need was seen for turning out students with varying technical backgrounds from the full-fledged engineer to well-trained technicians. This might eventually prompt the more poorly organized engineering schools to change their training to that of a technical institute.

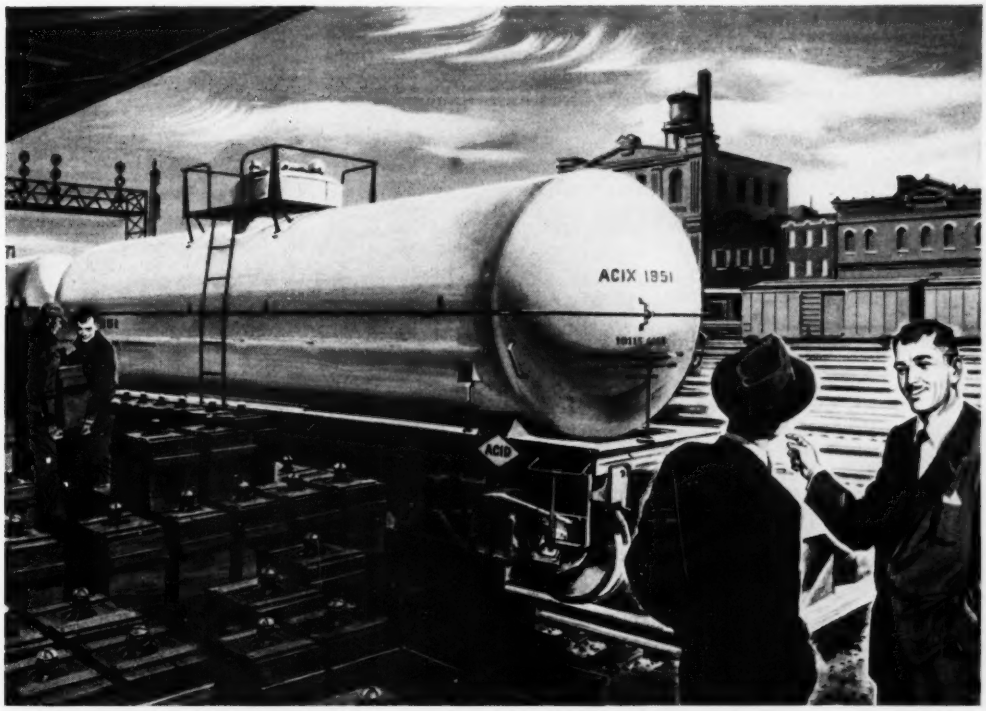
The consensus was that the five-year schools give more engineering education than most four-year schools.

## Engineering Council

With the Cornell Engineering Council acting as coordinator again this year, a joint meeting of the engineering organizations on campus was held on November 2 at Triangle Fraternity.

Representitives of twelve honorary and professional societies gathered to hear of the long-awaited reconstruction of the Engineers' Lounge in Sibley basement which will, for the first time, be the responsibility of Council. Jim Beveridge, ME '53, who was instrumental in starting the project, outlined the extensive facilities with which the

(*Continued on page 56*)




# This car replaced 615 "Bottles"

**ANOTHER ALCOA DEVELOPMENT STORY:**

In 1927, a chemical manufacturer asked us, "Why must some chemicals be handled in small drums or carboys . . . can't tank cars be built of aluminum?"

From our years of research, we knew that we had alloys compatible with many chemicals—and experience in fabrication methods dictated welding. The Field was inviting, and we decided to design and pay for the first aluminum tank car ourselves.

Our engineers designed an 8,000-gallon tank, to be welded together from 16 large aluminum plates. Working with a leading tank car builder, lessons which we had learned in other Alcoa developments enabled us to materially assist in the alloys selected, welding techniques and structural fabrication methods employed. One year later, in 1928, the car was completed. It was then tested in 20,000 miles of road service, while hauling glacial acetic acid—a typically tricky cargo. It weathered 3,500 recorded shocks—900 severe ones. That aluminum car is still in service!

Together with tank car builders, we have developed improved riveted and welded car designs, which are now "standard." Today there are over 1,300 aluminum tank cars carrying the fussy compounds that formerly traveled only in small containers.

This is typical of the development jobs we do at Alcoa. Others are under way now and more are waiting for mechanical, metallurgical, electrical, chemical and industrial engineers having the imagineering skill to tackle them. Perhaps you may be one of those men. ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pa.

"SEE IT NOW," with Edward R. Murrow, brings the world to your armchair...CBS-TV every Sunday...3:30 P.M. EST

*A business built on co-operation*

ALCOA®

ALUMINUM COMPANY OF AMERICA

## College News

(*Continued from page 54*)

lounge will be equipped. Intended to be a central meeting room for all engineering groups, as well as a comfortable place for students to relax during the day, the lounge will contain built-in cabinets and a desk where records may permanently stored. Provision will also be made to hang plaques of all the organizations, listing their name, object, and history. One wall will be specially designed so that motion pictures may be projected on it. To accomodate more than one meeting at a time, sliding, accordian-type doors will divide the lounge into two rooms. For refreshments, kitchen facilities will be installed, with the possibility that they may be used during the day for a snack bar. Plans also call for the ceiling to be lowered, elimination of the steam controls, a tile floor, improved lighting, and complete refurnishing.

Council also explained the function of the Engineering Calendar, which was originated last year to aid in the coordination of engineering activities. The idea is to have all the societies list their future meetings in a book which will be permanently located in the lounge. A list of the meetings will be compiled each week, mimeographed up, and distributed to the campus bulletin boards, keeping the student body well informed of what is taking place.

The meeting concluded with a discussion of the social events to be held during the coming year in connection with engineering.

## Rand Hall Sphere

Halloween night, October 31, brought the destruction of a project which had absorbed the time, energy, and interest of a number of Cornell's architects as well as a good amount of material expense. The globe which was the realization of construction principles developed by Buckminster Fuller, visiting design theorist at Cornell last spring, crashed to the roof of Rand Hall after a group of pranksters cut the supporting cables and tripod. Police had been warned of the possibility of the theft of the sphere, but the irreparable damage to the globe was not noticed for several days after the incident occurred.

An investment of about $600 and of some 4,000 man-hours, the sphere was constructed last spring by the fourth year class of the College of Architecture under Fuller's direction. The theory embodied in the structure was the result of years of original, creative work by Fuller, and the project required extensive mathematical analysis prior to construction. The framework of the sphere consisted entirely of ribs forming great circles (the diameter of each equalling the diameter of the sphere) which were joined to form a triangular network.

Fuller's theory involves analysis of external loads, wind and snow, as well as structural stresses. Great

(*Continued on page 60*)


**Designed to simplify close-tolerance measurements**

Versatile Brown & Sharpe Electronic Measuring Equipment is easily adapted to your machine or fixture design. It provides fast, accurate setting or gaging to .00001" with human error practically eliminated.

You can design inexpensive Gage Head Cartridges into several fixtures and use the same amplifier for all of them.

Find out the many advantages of Brown & Sharpe Electronic Measuring Equipment. Write for detailed bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

Gage Head Cartridge and Amplifier.

Gage Head Cartridge mounted on a fixture to measure a fixed gage—used with Amplifier.

Special fixture utilizes Gage Head Cartridge and Amplifier to measure internal angle accuracy to ±1½ seconds.

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**UNUSUAL CORNELL GIFTS**

**For the folks:**

Hand-made, hand-painted Chinaware $1.00 up
Drinking Glasses with Cornell Seal Packed in dozens ..... $4.50 up
Cornell Records—L.P. ..... $4.85

**For sister, brother:**

Juvenile T-shirts ..... 1.25
Cornell Cap — Cornell 19?? ..... 1.00
Scarf with Cornell insignia ..... 1.50
Animals of all kinds—from Dogs —to Zebras ..... from 2.00

**For Her:**

Say it with Cornell Seal Jewelry—The lasting gift — Your choice of bracelets, compacts, lockets, pins, or what-have you.

May we suggest you shop early. We will gift wrap and lay aside for you.

You'll enjoy trading at the
TRIANGLE BOOK SHOP

Evan J. Morris, Proprietor
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Store Hours: 8:15 A.M. to 8:00 P.M.

## how near?

Watch Airco in action right in your corner drug-store . . . carbonic gas puts the taste-tingling sparkle in ice-cream sodas, and a host of familiar soft drinks.

## how far?

Airco welding equipment joins the endless miles of steel pipe line sections . . . to keep a river of oil flowing across the Arabian desert.

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From putting the "zip" in well-known carbonated beverages . . . to welding a giant pipe line four thousand miles away—Airco products and processes find application literally 'round the world!

You name an industry adding to the comfort and convenience of daily living—from basic steel to food, to plastics, to transportation—to needed medical and health services . . . chances are you'll find an Air Reduction product adding to their present efficiency and contemplated future improvement. The story is told in "Facts about Air Reduction" . . . a copy is yours for the asking!

In fact, wherever progress is racing ahead to new frontiers, you'll find an *Air Reduction Product.*

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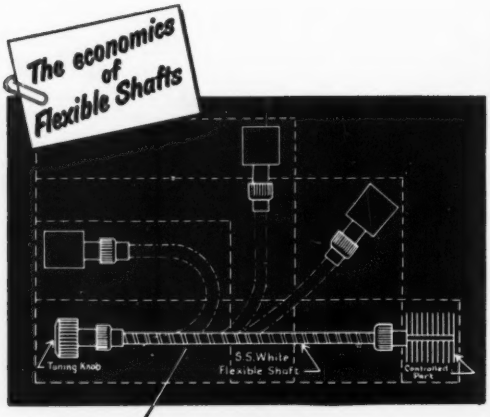


# S.S.White Flexible Shafts

***make it easy to meet space and dimensional requirements***

The flexible construction of an S.S.White remote control flexible shaft allows controlled parts to be mounted where desired to satisfy limited space conditions and to meet specific equipment dimensions. These versatile "Metal Muscles"® can be snaked around turns and curves to provide a one-piece, sensitive control coupling between any two points. As a result, the designer has more leeway in developing a design that meets existing operating, assembly, and servicing requirements and can be produced at lower cost.

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Many of the problems you'll face in industry will deal with the application of power drive and remote control with cost being an essential factor. That's why it will pay you to become familiar with S.S.White Flexible Shafts, because these "Metal Muscles"® offer important savings in transmitting power or control.

***SEND FOR THIS FREE FLEXIBLE SHAFT BOOKLET***

*Bulletin 5008 contains basic flexible shaft facts and shows how to select and apply flexible shafts. Write for a copy.*

THE S.S.White INDUSTRIAL DIVISION
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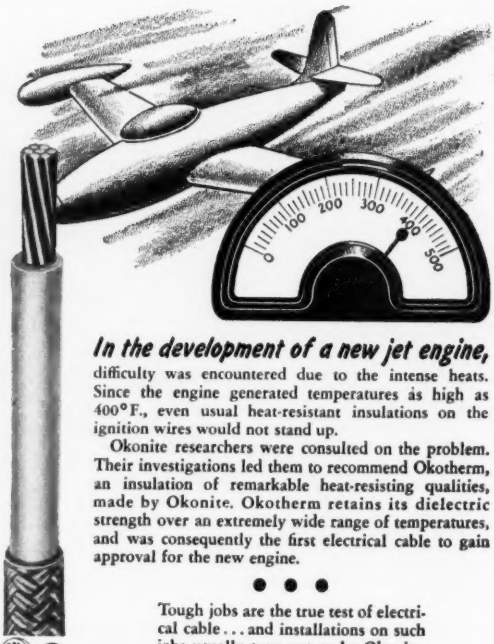



***In the development of a new jet engine,*** difficulty was encountered due to the intense heats. Since the engine generated temperatures as high as 400°F., even usual heat-resistant insulations on the ignition wires would not stand up.

Okonite researchers were consulted on the problem. Their investigations led them to recommend Okotherm, an insulation of remarkable heat-resisting qualities, made by Okonite. Okotherm retains its dielectric strength over an extremely wide range of temperatures, and was consequently the first electrical cable to gain approval for the new engine.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

8788

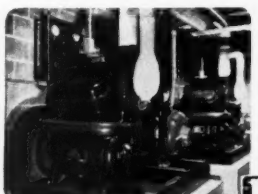
FRICK

***Air Conditioning and Refrigeration Serve Largest Super-market in Middle West***

Bettendorf's new store in St. Louis measures 164 ft. by 160 ft., has 200 employees. Two NEW "ECLIPSE" compressors provide air conditioning, while seven other Frick units cool eleven rooms — for meats, bakery products, vegetables, frozen foods, process work, etc.

Installation by L. V. Fleiter Co., St. Louis Distributors who have put Frick cooling equipment in five other super-markets recently.

*The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.*



Frick NEW "ECLIPSE" Compressors at Bettendorf's Super-Market, St. Louis

FRICK & CO
WAYNESBORO PENNA.
*Also Builders of Power Farming and Sawmill Machinery*

THE HYDROSTATIC TEST

Nobody can buy a length of cast iron pipe unless it has passed the Hydrostatic Test at the foundry. Every full length of cast iron pipe is subjected to this test under water pressures considerably higher than rated working pressures. It must pass the test or go to the scrap pile.

The Hydrostatic Test is the final one of a series of routine tests made by pipe manufacturers to assure that the quality of the pipe meets or exceeds the requirements of standard specifications for cast iron pressure pipe.

Few engineers realize the extent of the inspections, analyses and tests involved in the quality-control of cast iron pipe. Production controls start almost literally from the ground up with the inspection, analysis and checking of raw materials—continue with constant control of cupola operation and analysis of the melt—and end with inspections and a series of acceptance and routine tests of the finished product.

Members of the Cast Iron Pipe Research Association have established and attained scientific standards resulting in a superior product. These standards, as well as the physical and metallurgical controls by which they are maintained, provide assurance that cast iron pipe installed today will live up to or exceed service records such as that of the 130-year-old pipe shown.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.

**Section of 130-year-old cast iron water main still in service in Philadelphia, Pa.**

# CAST IRON PIPE SERVES FOR CENTURIES

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**CHRISTMAS SHOPPING AT THE CAMPUS LOUNGE SHOP**

For the first time, the campus community can shop for those Christmas gifts so popular with all Cornellians at our new Lounge Shop. We have an excellent selection and there is lots of room to browse around.

The Lounge Shop is campus headquarters for Christmas cards and our imprinting service can still offer prompt delivery, usually within 24 hours.

Drop in at the Lounge Shop or at the main store . . . convenient, congenial, complete, and our 10% trade dividend is a big saving.

▼

**THE CORNELL CAMPUS STORE**
**and**
**THE CAMPUS LOUNGE SHOP**

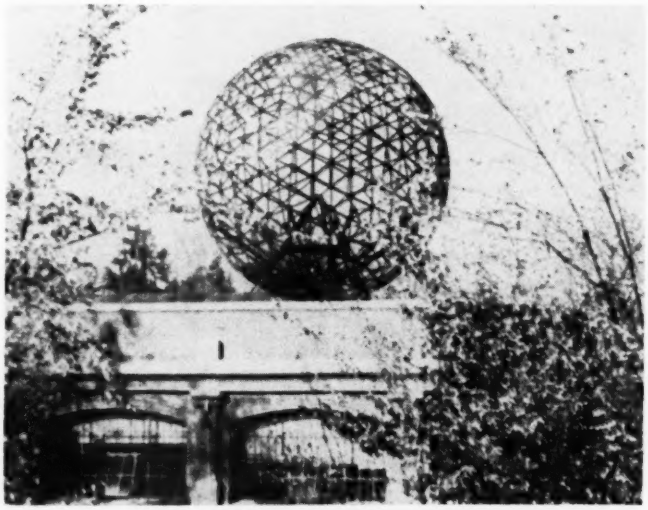
Barnes Hall

## College News

(*Continued from page* 56)

potentialities have been seen in his ideas; in conventional structures, his construction method could cut in half the weight of material needed for the dome of a building and could produce a much sounder design.

The Cornell sphere was the largest such structure built to date; it had received publicity on campus and had been pictured in *Fortune* magazine. The continents of the earth were represented in copper mesh on the surface, and the sphere, an inside-out planetarium was related to parts of its surroundings in accordance with the physical relationship of the earth and its universe.



**Rand Hall sphere which was recently destroyed.**

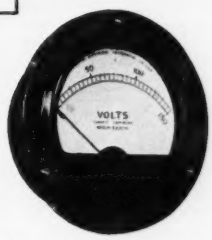
The project having been authorized as a permanent fixture on Rand Hall, it was to have served educational purposes for College of Architecture students and other observers. *Life* magazine was prevented from publishing a story on the sphere by its destruction. Two smaller globes have been constructed in other parts of the country, but the ruining of the Cornell sphere meant keen disappointment for Fuller and the Cornell architects and loss of good publicity for Cornell.

# What's Happening at CRUCIBLE

*about permanent alnico magnets*

## *automatic control—permanent magnets are partners in industrial progress*

One important part of the "automatic" factory is the requirement that measuring devices be accurate, rugged . . . and because of their use in such great volume they have to be low cost. It is a credit to instrument manufacturers that these meter miracles are being accomplished. Not only are the meters more sensitive, lower cost . . . but specialized problems in measurement are solved everyday with new and different instruments.



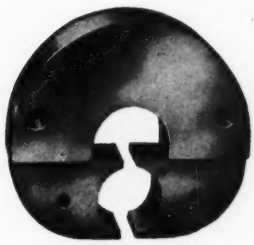

Marion Meter, Model 53RN.

## *here's how Marion cut magnet costs 1/3 . . . and built a better meter!*

Marion Electrical Instrument Company, prominent meter manufacturer, embarked on a plan of redesigning their meters to give improved service. The Marion Meter, Model 53RN shown here, is a good example of what is being accomplished.

In redesigning their instruments, Marion worked closely with Crucible magnet specialists. The recommendation was made to change from Alnico II to Alnico V for the magnetic alloy used in the meter's D'Arsonval movement. Then the magnet itself was redesigned. The overall effect was to reduce the weight of the magnet by 35%, cut the cost ⅓ . . . and increase the gap flux density which resulted in a 15% increase in the torque of the movement. The illustration shows the old and new design.

This development is typical of how Crucible is working to increase measuring efficiency with permanent alnico magnets. Have you a magnet application we can cut costs on by ⅓?

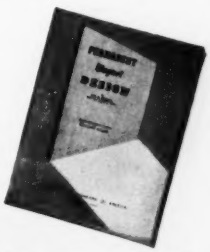


Former design of magnet assembly using Alnico II.

*before*

Note how redesigned magnet is made lighter because of reductions in area. The change from Alnico II to Alnico V with this design improved flux density.

*after*




## *magnet data book available*

Since the advent of the alnico market in 1936, Crucible has pioneered in the design and development of special magnet alloys. Send for your copy of Crucible's "PERMANENT MAGNET DESIGN". This booklet points out design factors in the selection of alnico magnets. CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, New York.

**CRUCIBLE** first name in special purpose steels

*52 years of Fine steelmaking*

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

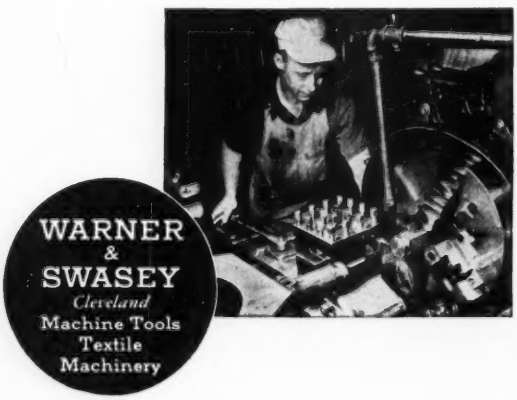
# How high taxes destroy jobs

JOHN SMITH is a good mechanic who saves his money and starts a little alley shop making widgets. He works hard, hires two good fellow-workers, his wife keeps the books, and he prospers. He keeps costs low, sells widgets at $2 each, and has a good year—he makes $1000 profit.

He's delighted. Now he'll buy modern machinery that will cut costs so he can sell widgets for $1.50. He knows he'll sell so many he can hire 3 more men and raise everybody's wage. Progress!

But no! The government steps in and takes a big part of his $1000 for taxes. So John Smith cannot buy the new machinery, 3 new jobs are not created, wages cannot be raised.

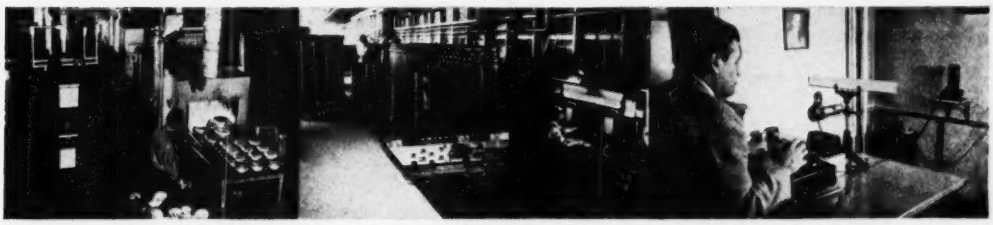
In other words, the expansion which would have increased widget supply and cut their cost from $2 to $1.50 does not take place—exorbitant taxes have throttled progress, kept supply restricted, and have kept prices high; taxes have held down the standard of living. In other words, taxes have reduced jobs and wages, and injured progress. ***Just as high taxes always do.***


YOU CAN MACHINE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY TURRET LATHES, AUTOMATICS AND TAPPING MACHINES

*L&N instruments "From Coal Pile to Bus Bar" in central station's control room*

*Electro-Chemograph*



*Speedomax control on annealing furnace*

*Speedomax control of ceramic kiln temperature*

*Research with K Potentiometer & accessories*

*Speedomax instruments in a refinery*

*Homocarb furnaces in auto plant*

*Aircraft testing*

# Like to Play a Part in Scientific and Industrial Progress?

• Because instruments are basic both to industrial and to scientific work, the instrument field ranks high in opportunity. As long as men make pig iron or pills, guns or butter, rockets or kilowatts or gasoline, industry will use more and more instruments on the production line. As long as scientists "unscrew the inscrutable" they will need instruments for college, Government and industrial research.

As a result, L&N job opportunities are quite varied. Openings in sales engineering utilize technical training in the examination of processes, and in selection and application of correct instruments in industrial plants. Other openings are in research, product development, production, advertising, inspection and other operations.

We make automatic, balance-type electrical instruments for controlling, measuring and indicating temperature, chemical concentration, combustion, frequency and load, flow and other conditions. We make heat-treating process equipments. We make laboratory-type instruments, in forms for scientists from freshman to Ph.D.-plus.

Our chosen portion of the automatic control and instrument field is in high-precision, high-dependability equipment. Commercially, we are one of the leaders; we have grown in every decade of our history, and continue to grow. And we are innovators; we pioneered many basic developments . . . are pioneering others, and will continue to do so.

Personnel-wise, the Company's policies are modern and progressive. We have long had group insurance, hospitalization, pensions and financial assistance for post-college education. Compensation includes profit-sharing as well as salary. L&N will continue to offer present opportunity and a substantial future.

Why not have a chat with our nearest District Office Manager? Or if you prefer, write our Personnel Manager, 4915 Stenton Ave., Phila. 44, Pa.

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Jrl Ad ENT-560(1)

# STRESS and STRAIN...

The old engineer pulled his favorite engine up to the water tank and briefed the new fireman. The fireman got up on the tender and brought the spout down all right but somehow his foot got caught in the chain and he stepped right into the tank.

As he floundered in the water, the engineer watched him with a jaundiced eye.

"Just fill the tank with water, Sonny," he drawled. "No need to stamp the stuff down."

* * *

Father: "When Abe Lincoln was your age, he was making his own living."

Son: "Yes, and when he was your age, he was President."

* * *

*"I want a shave," said the disgruntled Sergeant as he climbed into the barber's chair. "No haircut, no shampoo, no rum, witch hazel, hair tonic, hot towels, or face massage. I don't want the manicurist to hold my hand, nor the bootblack to handle my feet. I don't want to be brushed off, and I'll put on my coat myself. I just want a plain shave, with no trimmings. Understand that?"*

*"Yes, sir," said the barber quietly, "Lather, sir?"*

* * *

Salesman—"Sir, I have here something that's guaranteed to make you the life of the party, allow you to win friends and influence people, help you forge ahead in the business world, and in general make life a more pleasant and invigorating experience."

Engineer—"I'll take a fifth."

* * *

Physics proefssor: "If, in going down this incline, I gain four feet per second, what will be my condition after 25 seconds?"

Smart sophomore: "You'll be a centipede."

*Webster says that "taut" means tight. I guess the guys at college are taut a lot.*

* * *

Down where the whiskey looks and is drunk like water, strange ideas prevail as to what constitutes intoxication. On a village road one Sunday afternoon, a man lay in the hot sun with an empty bottle by his side.

"He's drunk, lock him up," said the sheriff. But a lady intervened hastily.

"He ain't drunk," she said, "I just seen his fingers move."

* * *

When a motorist who had crashed into a telephone pole and brought down the wires, recovered consciousness, his hands were clutching the wires.

"Thank Heavens," he exclaimed, "it's a harp."

* * *

M.E.: "Darling, tell me, how did you ever get Junior to eat olives?"

Wife: "Simple, I started him with Martinis."

* * *

A young man whose father had been hanged was filling out a college application. After the usual hereditary question, there was one asking the cause of the death of his parents. He thought a while and finally put down this answer: "Mother died of pneumonia. Father was taking part in a public ceremony when the platform gave away."

* * *

She reached below her dimpled knee
Into her rolled-down stocking
And there she found a roll of bills;
Ah me, it was rather shocking,
"Why don't you keep them in a bank?"
Inquired a nosy pryer.
"The principle is just the same
But the interest here is higher."

A bricklayer working on top of a building accidentally dropped a brick squarely on the head of a civil engineering student walking below.

"You'd better be careful up there," said the student. "You just made me bite my tongue."

* * *

*Beginner at fishing: "Oh, I've got a bite. What do I do?"*

*Her Husband: "Reel in your line."*

*Beginner: "I've done that, the fish is tight against the end of the pole. What do I do next?"*

*Helpful husband: "Hold it, I'll climb up the rod and stab it."*

* * *

Voter: "Why I wouldn't vote for you if you were St. Peter himself."

Candidate: "If I were St. Peter, you couldn't vote for me—you wouldn't be in my district."

* * *

Freshman German Student: "What is castor oil known as in Holland?"

Senior: "Old Dutch Cleanser."

* * *

*Some members of the Hoover Committee were questioning a civil service worker in Washington. "What do you do here?" they asked him.*

*The clerk, fed up with red tape, buck-passing, office politics, and, above all, efficiency experts, answered, "I don't do a darn thing."*

*The committee went into a huddle, made a few notes, and then asked the second man, "And you, what's your job here?"*

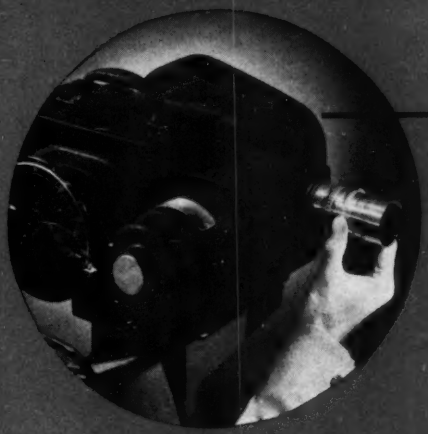
*"I don't do a thing either."*

*The committee leader's ears perked up. "Mmmm," he said, "I suspect that there's duplication here."*

* * *

A university is an institution with rooms for 20,000 in the classrooms and 80,000 in the stadium.

# Engineering has a precision tool in photography



WHATEVER YOUR BRANCH of engineering, you'll find photography an increasingly valuable aid. With it you can picture lightning-fast operations—or extremely slow processes—at speeds suitable for study. You can capture fleeting instrument traces, study internal stresses in machine parts, examine metal structure and do countless other things.

The application of photography to engineering problems has become a specialty in itself. This has led graduates in the physical sciences and in engineering to find positions with the Eastman Kodak Company. If you are interested, write to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.

**Here high speed** motion-picture photography shows a cavity in a column of water produced when a 5-mm rod was shot through it at 12.2 meters per second. By taking the pictures at 3200 per second and projecting them at the standard 16 per second, time is "magnified" 200 times.

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## MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

***"Are my opportunities for advancement as good in a large company, like G.E., as they are in a small firm?"***

**. . . Allen E. Galson, Cornell University, 1953**

Two answers to this question, presented at a student information meeting held in July, 1952, between G-E personnel and representative college students, are printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 221-6, General Electric Co., Schenectady, N. Y.

**M. M. BORING,** *Engineering Services Division* . . . I think your opportunities for advancement are as good, if not better, in a large company. There is one point which is often overlooked in making such a comparison. That is, that any large company, and especially one as diversified as General Electric, is really made up of a number of small companies, but with more opportunities than you find in a small firm. We are an organization of many businesses.

With many diverse fields there is greater opportunity for college men and women to find the work most suited to their desires, talents, and abilities. With a wider choice of jobs there is more opportunity to get into work you really enjoy.

The college graduate, working for G.E., will discover new fields opening up to him. He will probably discover that there is some activity in which he is particularly interested. There are no fixed paths for college graduates at G.E. The college man or woman who enters our Company does not commit himself irrevocably to one type of work. It's our tradition to encourage the newcomer to look around, try several different assignments, and find the work most satisfying to him and to which he can make the greatest contribution. In G.E. the college graduate can investigate many types of work before choosing his field. And, he can change jobs without having to leave the Company, or lose the advantages connected with length of service—an impossibility in many small firms.

**F. K. McCUNE,** *Engineering Services Division* . . . There is one Company function which, I believe, provides great opportunities for advancement in General Electric. That is our system of training programs, designed to provide a continuous succession of young people to assume responsibilities for the Company's operation and management in the future. The principle of this training has been to develop men and women by providing them with productive employment, by giving them the opportunity to reveal their abilities, and by providing them with practical classroom study designed to broaden their understanding of the electrical industry and of business in general.

The most important contribution of the training programs has been in developing leaders for our Company. Many of the officers and executives in responsible key positions today are graduates of one or another of these programs.

Many small firms cannot afford to spend, either in time or money, the amount we do in preparing young people for better future positions. We believe, however, that these training programs are one of the best assurances that we will have men and women with qualities of ability, character, and leadership in our Company, prepared to cope with the problems and responsibilities of our complex society.

*You can put your confidence in—*

**GENERAL ELECTRIC**